PROCEEDINGS

OF THE

LITERARY AND PHILOSOPHICAL SOCIETY

OF

LIVERPOOL,

DURING THE

SIXTY-NINTH SESSION, 1879-80.

No. XXXIV.

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ORDINARY MEMBERS,

ON THE SOCIETY'S ROLL AT THE CLOSE OF THE 69TH SESSION.

CORRECTED TO SEPTEMBER, 1880.

Life Members are marked with an Asterisk.

Oct. 21, 1872 Abbott, Joseph, B.A., 2, *Picton-street, Wavertree-road.*

Oct. 21, 1878 Adair, William, 6, *Greenheys-road, Prince's Park.*

March 24, 1879 Alexander, William, M.D., 102, *Bedford-street South.*

Nov. 4, 1867 Allen, John Fenwick, *Peaseley Vale, St. Helens.*

Nov. 12, 1877 Allman, G. W., *Ullet Road.*

March 7, 1864 Archer, F., B.A., Trin. Col., Cantab., *Boundary Cottage, Little Crosby.*

*Nov. 28, 1858 Archer, T. C., F.R.S.E., F.R.SS.A., Director of the Industrial Museum, *Edinburgh.*

Dec. 14, 1868 Ashe, Theop. Fielding, 9–15, *Atherton-street.*

Nov. 26, 1877 Atkins, H. Norwood, 7, *Hardy-street.*

Nov. 12, 1877 Atkinson, John, *Manchester-street.*

Jan. 11, 1864 Bagshaw, John, 87, *Church-street*, and 64, *Cressington Park.*

Nov. 13, 1876 Ball, Geo. Hy., *The Priory, St. George's Mount, New Brighton.*

April 20, 1874 Barton, Rev. John, M.A., *Vicarage, Rainhill.*

Mar. 18, 1878 Beall, Geo., F.R.G.S., 4, *Beech Mount, Kensington*, or 4, *Custom House Arcade.*

Oct. 21, 1878 Beasley, Hy. Charles, *Acrefield, Woolton.*
Nov. 15, 1869 Beer, Joseph B. de, *Northern Assurance Chambers, Tithebarn-street.*
Feb. 22, 1875 Bellew, Thomas, A., *Cunard Mail Office,* 8, *Water-street.*
Nov. 15, 1875 Bellis, William, *Sunny Bank, Victoria Park, Wavertree.*
Jan. 27, 1879 Beloe, Chas. H., 16, *Falkner-square,* and 18, *Harrington-street.*
Dec. 10, 1866 Benas, Baron Louis, *Imperial Chambers, Dale-street.*
Nov. 27, 1865 Biggs, Arthur Worthington, 28, *Exchange-street East,* and 11, *Percy-street.*
Feb. 6, 1872 Biggs, John H. W., 6, *Windsor-buildings, George-street.*
Oct. 31, 1850 Birch, James (Messrs. Reiss Bros.), 12, *The Temple.*
Oct. 15, 1877 Birchall, F. W., *Westminster-road, Kirkdale.*
Jan. 25, 1864 Birchall, James, *Kirkdale,* HON. SECRETARY.
March 9, 1866 Blood, William, *Chamber of Commerce,* and *Greta Mount,* 5, *Woodchurch-road, Birkenhead.*
Dec. 16, 1878 Bogue, Robert Lachlan, *The College, Shaw-street.*
Feb. 18, 1878 Bouch, John, 28, *Berkley-street.*
Nov. 26, 1866 Boult, Joseph, 15D, *Exchange Buildings, W.*
Oct. 19, 1868 Bower, Anthony, *Vauxhall Foundry,* and *Bowersdale, Seaforth.*
Oct. 21, 1872 Bowring, C. T. *Elmsleigh, Prince's-Park,* and 20, *Lancaster-buildings, Tithebarn-street.*
Dec. 15, 1878 Brass, Joseph, M.D., 6, *Upper Parliament-street.*
Nov. 4, 1867 Bramwell, Ed., *Cowley Hill, St. Helens.*
Jan. 27, 1878 Bremner, H. H., 15, *Lord-street.*
Nov. 12, 1866 Browne, Edgar A., 86, *Bedford-street, South.*
Oct. 18, 1869 Brown, Dr. J. Campbell, D.Sc., F.C.S., *School of Medicine, Dover-street.*
Oct. 30, 1876 Bulman, Richard, 2, *India-buildings, Water-street.*
Feb. 4, 1867 Burden, Edward, 128, *Upper Parliament-street.*

April 18, 1864 Burne, Joseph, *Royal Insurance Office*, 1, *North John-street*, and *Higher Tranmere.*

Nov. 12, 1866 Butler, Rev. George, *The College, Shaw-street.*

*May 1, 1848 Byerley, Isaac, F.L.S., F.R.C S., *Victoria-road, Seacombe.*

Nov. 3, 1862 Cameron, John, M.D., M.R.C.P., Physician to the Southern Hospital, 4, *Rodney-street.*

Dec. 2, 1872 Carey, Eustace, *Appleton-in-Widnes, near Warrington.*

Jan. 9, 1865 Cariss, Astrup, *Orange-court, Castle-street.*

Nov. 13, 1876 Carson, Thomas, M.D., 322, *Upper Parliament-street.*

Mar. 4, 1872 Carter, W., M.D., Lond., 74, *Rodney-street.*

Dec. 2, 1861 Chadburn, William, 71, *Lord-street.*

April 3, 1876 Chantrell, G. F., 1, *St. James's Mount.*

Oct. 18, 1869 Cook, Henry James, *Byrom-street*, and *Burbo House, Blundellsands.*

Dec. 13, 1875 Cowell, Peter, *Free Library, William Brown-street.*

Oct. 6, 1868 Crosfield, William, Jun., 8, *Temple-court*, and *Alexandra-drive, Ullet-road.*

Nov. 12, 1866 Davies, E., F.C.S., *The Laboratory, Royal Institution, Colquitt-street.*

Nov. 2, 1868 Dawbarn William, *The Temple, Dale-street*, and *Mossley-hill.*

Oct. 1, 1866 Dawson, Thomas, 26, *Rodney-street.*

April 6, 1874 Dodd, John, 6, *Thomas-street*, and 2, *Derby-terrace, Rock Ferry.*

Nov. 3, 1879 Dopson, Daniel, L.D.S., R.C.S.I., 10, *Oxford-street.*

Nov. 27, 1868 Dove, John M., *Claughton.*

Nov. 1, 1875 Doyle, Jas. F., 4, *Harrington-street*, and *Merton-road, Bootle.*

Jan. 28, 1848 Drysdale, John James, M.D.Edin., M.R.C.S. Edin., 36, *Rodney-street.*

Nov. 1, 1875 Edmonds, William, *Edmund-street Chambers, Edmund-street.*

*Nov. 27, 1848 Edwards, J. B., Ph.D. Gies, F.C.S., Professor Medical Faculty of Bishop's College, *Montreal*,

Mar. 21, 1870 Edwards, Edward E. (Smith, Edwards & Co.). *Adelaide-buildings*, 4, *Chapel-street.*

April 7, 1862 English, Charles J., 26, *Chapel-street*, and 26, *Falkner-square.*

April 20, 1874 English, Robert A., 26, *Falkner-square.*

Dec. 1, 1879 Eyre, Edmund Phipps, 1, *Cook-street.*

Nov. 3, 1879 Faure, Emmanuel, 12, *Hampstead-road.*

*Dec. 13, 1852 Ferguson, William, F.L.S., F.G.S., *Kinmundy House*, near *Mintlaw, N.B.*

Jan. 13, 1879 Fingland, Wm., *High-street, Wavertree.*

Nov. 15, 1875 Fleming, E. L., F.C.S., *Borax Works, Old Swan.*

Oct, 1, 1866 Fletcher, Alfred E., F.C.S., H.M. Inspector of Alkali Works for the Western District, 5, *Edge-lane.*

*Mar. 19, 1855 Foard, James Thomas, 8, *Harcourt-buildings, Temple, London, E.C.*

Nov. 16, 1874 Fothergill, Charles George, 41, *Rodney-street.*

Jan. 12, 1874 Frost, John Pownall, 10, *North John-street.*

Nov. 12, 1877 Galley, Jno., 8, *Newstead-road.*

Nov. 29, 1875 Gardner, William, *Ash Lea, Oak-hill Park.*

Nov. 26, 1877 Gatty, Charles T., Mayer Museum, Free Public Museum, *William Brown-street.*

*Feb. 6, 1854 Gee, Robert, M.D. Heidelb., M.R.C.P., Lecturer on Diseases of Children, Royal Infirmary School of Medicine; Physician Workhouse Hospital, 5, *Abercromby-square.*

Oct. 20, 1870 Gracey, Robert, F.C.S. (Messrs. Cope Bros.), *Lord Nelson-street.*

Oct. 29, 1877 Green, Robt. Frederick, 66, *Whitechapel.*

Nov. 14, 1858 Greenwood, Henry, 32, *Castle-street*, and *Stanley Park.*

Nov. 16, 1874 Grindley, Benjamin H., *Albion Office, Sir Thomas's-buildings.*

Nov. 16, 1874 Guthrie, Malcolm, 2, *Parkfield-road.*

Jan. 22, 1855 Hakes, James, F.R.C.S., Surgeon to the Royal Infirmary, 80, *Hope-street.*

Oct. 18, 1875 Hale, Philip A., Bank of England, *Castle-street.*

Oct. 21, 1872 Halliwell, Joseph, 10, *College-lane.*

*Jan. 21, 1856 Hardman, Lawrence, 85, *Rock Park, Rock Ferry.*

Dec. 13, 1875 Harpin, E., 46, *Onslow-road, Elm Park, Fairfield.*

Nov. 30, 1874 Harvey, Henry, M.B., *High-street, Wavertree.*

Feb. 6, 1865 Hassan, Rev. E., *Alma-terrace, Sandown-lane.*

Nov. 13, 1865 Hayward, John Williams, M.D., 117, *Grove-street.*

Feb. 6, 1865 Hebson, Douglas, 13, *Tower Chambers,* and 58, *Bedford-street South.*

Nov. 4, 1872 Hicks, John Sibley, L.R.C.P., 2, *Erskine-street.*

March 22, 1869 Higgin, Thomas, F.L.S., 33, *Tower-buildings,* and *Huyton.*

Dec. 28, 1846 Higgins, Rev. H. H., M.A., Cantab., F.C.P.S., *Rainhill,* Ex-President.

Feb. 18, 1878 Hilton, Benjamin H., Crown Life Assurance, 5a, *Exchange-buildings.*

Nov. 16, 1868 Holden, Adam, 48, *Church-street,* and 2, *Carlton-terrace, Milton-road.*

March 9, 1868 Holme, James, 10, *Huskisson-street,* and *Eldon Chambers, South John-street.*

Nov. 30, 1874 Holme, Rev. Arthur P., *Tattenhall, near Chester.*

Dec. 15, 1879 Holmes, Robert Stratten, 27, *Anfield-road.*

*Dec. 14, 1862 Holt, Robert Durning, 6, *India-buildings,* and 29, *Edge-lane.*

April 9, 1877 Hooper, Richard Bennett, 6, *Loudon Grove, North Hill-street.*

Nov. 4, 1878 Howie, J. Muir, M.B., *Rodney-street.*

March 10, 1879 Hughes, John W., *Hornby-road, Wavertree.*

Jan. 24, 1876 Hughes, Lewis, 88, *St. Domingo-vale, Everton*

*Nov. 13, 1854 Hunter, John, Member Historic Society, Pennsylvania, *Halifax, Nova Scotia.*

Dec. 13, 1875 Hutchinson, Joseph B., M.R.C.S., 77, *Upper Parliament-street.*

*April 29, 1850 Ihne, William, Ph.D. Bonn, *Villa Felseck, Heidelberg*, Ex-President.

Oct. 19, 1874 Imlach, Francis, M.D., 158, *Bedford-street South.*

Jan. 26, 1868 Johnson, Richard C., F.R.A.S., *Queen-buildings, Dale-street*, and *Higher Bebington*, Hon. Treasurer.

Oct. 21, 1878 Johnson, John Hampden, 22, *Queen-buildings*, 11, *Dale-street.*

Dec. 15, 1879 Johnson, Stuart M., 79, *Hutchinson-street.*

Mar. 19, 1877 Johnson, Rev. H. I., M.A., *Royal Institution School*, and *Penrhyn House, Ullet-road.*

Oct. 21, 1878 Johnston, Thomas B., 7, *Lord-street.*

Feb. 24, 1868 Jones, Charles W., *Field House, Wavertree.*

*April 4, 1852 Jones, Morris Charles, F.S.A., F.S.A.Scot., 20, *Abercromby-square.*

Oct. 18, 1869 Jones, William Bolton, 20, *South Castle-street.*

Nov. 30, 1874 Joseph, Rev. Morris, 67, *Canning-street.*

Oct. 21, 1878 Ker, R. Wilson, 151, *Bedford-street South.*

Nov. 1, 1869 Kinsman, W. N., 8, *Derwent-road, Stoneycroft.*

Jan. 27, 1879 Kynaston, J. W., 149, *Kensington.*

*Jan. 14, 1839 Lassell, William, F.R.SS., L. and E., F.R.A.S., *Maidenhead, Berks.*

Oct. 21, 1844 Lear, John, *Stoneby Cottage, Stoneby Green, New Brighton.*

Nov. 8, 1878 Lee, Hamilton (Messrs. Lee & Nightingale), *North John-street.*

Nov. 8, 1878 Lee, Harold (Messrs. Lee & Nightingale), *North John-street.*

Nov. 8, 1879 Leeman, Rev. William Luther, M.A., *The Vicarage, Seaforth.*

Dec. 11, 1871 Leigh, Richmond, M.R.C.S., L.S.A., Physician to St. George's Hospital for Diseases of the Skin, 105, *Park-road.*

Dec. 1, 1879 Long, Rev. R. E., *Cambridge House, Upper Parliament-street.*

Jan. 18, 1879 Longuet-Higgins, Henry, *Rainhill.*

Nov. 17, 1879 Lunt, Rev. Thomas, 97, *Everton-road.*

Nov. 1, 1875 Lutschaunig, Alfred, *Cable-street.*

April 17, 1865 McCheane, Wm., M.R.C.S., 47, *Shaw-street.*

March 23, 1874 McCulloch, D.B., 23, *Queen-buildings, Dale-street.*

Oct. 30, 1876 McGrath, T. J., M.D., *South Dispensary, Upper Parliament-street.*

April 20, 1868 Marples, David, *Melvill-chambers, Lord-street,* and 5, *Mount-grove, Oxton, Birkenhead.*

Nov. 14, 1870 Marples, Joseph, 23, *Leece-street,* and *Carlton-road, Tranmere.*

Nov. 17, 1878 Marples, Josiah, *Melvill Chambers, Lord-street,* and *Broomfield, Egremont.*

Feb. 19, 1877 Marples, William, 8, *Mathew-street,* and *Alfred-road, Birkenhead.*

Feb. 9, 1874 Marsden, Peter Crook, *Lymefield, Heaton, near Bolton.*

Jan. 21, 1889 Martin, Studley, 27, *Brown's-buildings,* and 177, *Bedford-street South.*

Feb. 20, 1871 Mason, Alfred H., F.C.S., Lond. and Berlin, 56, *Hanover-street.*

Oct. 20, 1879 McArthur, Charles, F18, *Exchange-buildings.*

Nov. 17, 1878 Mellor, James, Jun., *Weston, Blundellsands.*

Dec. 14, 1874 Mellor, John, *Stansty, Waterloo Park, Waterloo.*

Oct. 20, 1879 Mellor, Thomas, *Edgewater, Blundellsands.*

Oct. 31, 1859 Moore, Thomas John, Corr. Mem. Z.S.L., Curator Free Public Museum, *William Brown-street,* VICE-PRESIDENT.

Nov. 15, 1869 Morgan, Alfred, 26, *North John-street,* and 2, *Rathbone-terrace, Wellington-road, Wavertree.*

Jan. 8, 1855 Morton, Geo. Highfield, F.G.S., 122, *London-road.*

April 16, 1849 Moss, Rev. John James, B.A., *East Lydford Hall, Somerton, Somerset.*

Oct, 29, 1850 Mott, Albert Julius, F.G.S., *Adsett Court, Westbury-on-Severn,* EX-PRESIDENT.

April 3, 1854 Mott, Charles Grey, 27, *Argyle-street, Birkenhead,* and *Cavendish-road, Birkenhead Park.*

Dec. 16, 1878 Murphy, Rev. P., *St. Anthony's, Scotland-road.*

*Oct. 21, 1867 Muspratt, E. K., *Seaforth Hall, Seaforth.*

Oct. 20, 1865 Nevins, John Birkbeck, M.D.Lond., M.R.C.S., Late Lecturer on Materia Medica, Royal Infirmary School of Medicine, 3, *Abercromby-square,* Ex-President.

Feb. 6, 1865 Newton, John, M.R.C.S., 20, *Marmaduke-street, Edge-hill.*

Feb. 18, 1878 Nicholson, Robert, 11, *Harrington-street.*

Nov. 2, 1868 Norrie, Rev. B. A. W., M.A.Cantab., *The College School, Huyton.*

*Oct. 15, 1855 North, Alfred, 28, *Lansdown-crescent, Notting-hill, London, W.*

Jan. 8, 1877 Ogston, James, *Maresfield, Wavertree.*

Dec. 18, 1866 Owen, Peter (Farnworth & Jardine), *Liverpool and London Chambers.*

Nov. 2, 1874 Palmer, John Linton, F.S.A., F.R.G.S., Fleet Surgeon, R.N., 24, *Rock Park, Rock Ferry.*

Dec. 15, 1878 Parnell, E. W., 32, *Canning-street.*

Mar. 19, 1877 Parry, J. F., *Sandon-terrace.*

Jan. 9, 1871 Patterson, J., 16, *Devonshire-road, Prince's Park.*

Nov. 4, 1861 Philip, Thomas D., 49, *South Castle-street,* and *Holly-road, Fairfield.*

Dec. 28, 1846 Picton, James Alanson, F.S.A., Chairman of the Library and Museum Committee, 11, *Dale-street,* and *Sandy Knowe, Wavertree,* Ex-President.

Nov. 1, 1875 Picton, William Henry, *Woodlea, Waterloo Park, Waterloo.*

Feb. 24, 1879 Plastow, William, 383, *Scotland-road.*

April 30, 1866 Prag, Rev. Jacob, 99, *Upper Warwick-street.*

Nov. 18, 1871 Proctor, Peter, M.R.C.S., and L.S.A.Lond., 17, *Hamilton-square, Birkenhead.*

March 4, 1878 Radcliffe, David, 26, *Huskisson-street.*

*Jan. 22, 1866 Raffles, William Winter, *Sunnyside, Prince's Park,* and *Glan-y-mor, Penmaenmawr.*

Nov. 12, 1860 Rathbone, Philip H., *Liverpool and London Chambers* (H), and *Greenbank Cottage, Wavertree.*

March 24, 1862 Rathbone, Richard Reynolds, 17, *Lancaster-buildings, Tithebarn-street,* and *Beechwood House, Grassendale.*

*Jan. 7, 1856 Rawlins, Charles Edward, 12, *Rumford-court, Rumford-place,* and *Rock Mount, Rainhill.*

Jan. 9, 1870 Rawlins, Gerald W., *Brook Cottage, Rainhill.*

Jan. 7, 1878 Read Robert, 28, *Berkeley-street.*

Nov. 17, 1851 Redish, Joseph Carter, *Lyceum, Bold-street.*

Feb. 19, 1877 Rich, J. D., *General Post Office,* and *Ivy Lodge, Linnet-lane.*

Nov. 29, 1869 Roberts, Isaac, F.G.S., *Kennessee, Maghull.*

Dec. 4, 1876 Roberts, Richard (Messrs. Roberts & Son), 18, *Hackins-hey,* and *Mossley-hill.*

Nov. 26, 1877 Roberts, J. Geo., L.D.S., R.C.S.I., 27, *Hope-street.*

Feb. 4, 1867 Robinson, Joseph F., 1, *Knowsley-bs., Tithebarn-st.*

Oct. 4, 1869 Rogers, J. Frederick, 7, *Victoria-street,* and 22, *Ullet-road, Prince's Park.*

Jan. 10, 1876 Rogerson, George Russell, F.R.A.S., F.R.G.S., F.R.S.L., *Cook-street,* and *Allerton.*

Oct. 21, 1878 Roose, Edward B., 26, *North John-street.*

Oct. 29, 1877 Rosenheim, Jos. C., *Sunny Bank, Prince's Park.*

April 18, 1854 Rowe, James, 14, *South Castle-street,* and 105, *Shaw-street.*

Jan. 22, 1872 Russell, Edward R., "*Daily Post*" *Office, Victoria-street,* and 58, *Bedford-street,* PRESIDENT.

Feb. 18, 1878 Russell, W., *Compton Hotel, Church-street.*

April 7, 1862 Samuel, Harry S., 11, *Orange-court,* and 2, *Canning-street.*

Nov. 30, 1874 Samuel, William Hy., 145, *Upper Parliament-st.*

March 19, 1866 Sephton, Rev. John, M.A., *Liverpool Institute.*

Dec. 2, 1878 Serjeant, Jno., 128, *London-road.*

Nov. 2, 1868 Sharp, Charles, *Liverpool Institute.*

Jan. 7, 1878 Shearer, George, M.D., 157, *Upper Parliament-street.*

Nov. 16, 1868 Sheldon, E. M., M.R.C.S., 228, *Boundary-street.*

Oct. 18, 1875 Simpson, James, 10, *Rumford-place.*

Nov. 7, 1864 Skinner, Thomas, M.D.Edin., *Dunedin House, 64, Upper Parliament-street.*

Jan. 26, 1880 Skinner, Hilton.

Nov. 4, 1878 Slater, William, 5, *Tithebarn-street.*

Feb. 24, 1879 Slatter, G. W., A.R.C.Sc., F.C.S., 37, *Arundel-street, Prince's road.*

Dec. 10, 1866 Smith, Elisha (Henry Nash & Co.), 12, *Tower-buildings North.*

April 4, 1870 Smith, James, 9, *Lord-street, and Ribblesdale Villas,* 22, *Merton-road, Bootle.*

Feb. 28, 1868 Smith, J. Simm, 1, *Warham-road, Croydon.*

Feb. 24, 1862 Snape, Joseph, Lecturer on Dental Surgery, Royal Infirmary School of Medicine, 75, *Rodney-street.*

Nov. 27, 1877 Snape, Thos., 10, *Kinglake-street, Edgehill.*

April 20, 1874 Snow, Rev. T., M.A., 55, *Seel-street.*

Dec. 2, 1878 Southward, Rev. W. T., M.A., Fellow of St. Catharine's College, Cambridge, *White House, Huyton.*

Nov. 18, 1878 Sparke, Morton, *Charlwood House, Tarbuck-road, Roby.*

Nov. 12, 1860 Spence, Charles, 4, *Old Hall-street.*

Feb. 10, 1862 Spence, James, 18, *Brown's-buildings, Exchange,* and 10, *Abercromby-square.*

Jan. 18, 1868 Stearn, C. H., Bank of England, *Castle-street,* and 8, *Eldon-terrace, Rock Ferry.*

Nov. 18, 1878 Steel, Richard, 18, *Hackins Hey.*

Nov. 13, 1876 Stephens, Thomas English, *Seafield, Victoria-road, New Brighton.*

Oct. 24, 1876 Stern, Rev. William, D.D., 8, *Hope-place.*

Nov. 1, 1875 Stevenson, John, *Prince Alfred-road, Wavertree.*

Jan. 9, 1865 Stewart, Robert E., L.D.S., R.C.S., Dental Surgeon Royal Southern Hospital and Liverpool Dental Hospital, 37, *Rodney-street.*

Feb. 18, 1878 Symes, Charles, Ph.D., 20, *St. James's-road.*

Feb. 18, 1878 Taylor, Geo., 28, *Seel-street.*

*Feb. 19, 1865 Taylor, John Stopford, M.D.Aberd., F.R.G.S., 2, *Millbank-terrace, Anfield-road.*

Nov. 29, 1875 Tetley, John H., *Sunnyside*, 21, *Rock Park, Rock Ferry.*

Feb. 19, 1877 Thacker, Reginald P., *Mandeville, Aigburth-road.*

Oct. 21, 1878 Thompson, J. W., B.A.Lond., 17A., *South Castle-street.*

March 8, 1880 Tickle, W. H., *Cretan House, Oak Hill Park.*

Nov. 17, 1850 Tinling, Chas., *Victoria-street*, and 29, *Onslow-road, Elm Park.*

Dec. 4, 1876 Torpy, Rev. Lorenzo, M.A., *Borrowash, Derby.*

*Feb, 19, 1844 Turnbull, James Muter, M.D.Edin., M.R.C.P., Physician Royal Infirmary, 86, *Rodney-street.*

Oct. 21, 1861 Unwin, William Andrew, 11, *Rumford-place.*

Nov. 8, 1879 Varley, Rev. Henry, M.A., 28, *Loudon Grove, Prince's Park.*

Oct. 20, 1879 Veevers, Samuel, 6, *Windsor-buildings.*

Dec. 2, 1872 Waite, Wm. Hy, D.D.S.,L.D.S., 10, *Oxford-street.*

Feb. 24, 1879 Walker, R. S., J.P., Resident Secretary, General Insurance Co., 5, *Brunswick-street.*

Mar. 18, 1861 Walker, Thomas Shadford, M.R.C.S., 88, *Rodney-street.*

Jan. 27, 1862 Walmsley, Gilbert G., 50, *Lord-street.*

Jan. 9, 1865 Walthew, William, *Phœnix Chambers*, and *Vine Cottage, Aughton.*

Feb. 19, 1877 Wallace, John, M.D., *Gambier-terrace.*

Mar. 4, 1872 Ward, Thomas, *Brooklands House, Northwich.*

Dec. 2, 1861 Weightman, William Henry, *Minster-buildings, Church-street*, and *Cambridge-road, Seaforth.*

Oct. 30, 1876 Weightman Arthur (Messrs. Field & Weightman), *Talbot Chambers*, 8, *Fenwick-street, W.*

April 7, 1862 Whittle, Ewing, M.D., Lecturer on Medical Jurisprudence Royal Infirmary School of Medicine, 77A, *Upper Parliament-street.*

Nov. 2, 1874 Wolf, Jas. O. de (Messrs. T. C. Jones & Co.), 26, *Chapel-street.*

Mar. 18, 1861 Wood, George S. (Messrs. Abraham & Co.), 20, *Lord-street*, and *Bellevue-road, Wavertree.*

Nov. 14, 1870 Wood, John J. (Messrs. Abraham & Co.), 20, *Lord-street*

Nov. 29, 1875 Yates, D. E., 9, *Rumford-place*, and 38, *Huskisson-street.*

Nov. 13, 1876 Yates, Edward Wilson, 37, *Castle-street.*

Nov. 2, 1874 Young Henry, *South Castle-street.*

HONORARY MEMBERS.

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1.—1838 The Right Hon. Dudley Ryder, Earl of Harrowby, K.G., D.C.L., F.R.S., etc., *Sandon Hall, Staffordshire,* and 39, *Grosvenor-square, London, W.*

2.—1836 The Most Noble William, Duke of Devonshire, K.G., M.A., F.R.S., D.C.L., F.G.S., etc., Chancellor of the University of Cambridge, *Chatsworth, Derbyshire, etc.*, and 78, *Piccadilly, London, W.*

3.—1838 Sir George Biddell Airy, K.C.B., M.A., L.L.D., D.C.L., F.R.S., F.R.A.S., etc., Astronomer Royal, *Royal Observatory, Greenwich.*

4.—1840 James Nasmyth, F.R.S., *Penshurst, Kent.*

5.—1844 T. B. Hall, *Crane House, Yarmouth.*

6.—1844 Peter Rylands, M.P., *Warrington.*

7.—1844 Thomas Rymer Jones, F.R.S., F.Z.S., F.L.S., etc., 52, *Cornwall-road, Westbourne Park, London, W.*

8.—1844 William B. Carpenter, M.D., F.R.S., F.L.S., Corresponding Member of the Institute of France, etc., *London.*

9.—1850 The Rev. Canon St. Vincent Beechy, M.A., Rector of Hilgay, *Norfolk.*

10.—1851 The Rev. Robert Bickersteth Mayor, B.D., Rector of Frating, *Essex.*

11.—1857 Thomas Joseph B. Hutchinson, F.R.G.S., F.R.S.L., F.E.S., *Ballinescar Lodge, Curracloe, co. Wexford.*

12.—1861 The Rev. Thomas P. Kirkman, M.A., F.R.S., Rector of Croft, *near Warrington.*

13.—1865 The Right Rev. T. N. Staley, D.D., late Bishop of Honolulu, Vicar of Croxhall, *Staffordshire.*

14.—1865 Edward J. Reed, K.C.B., M.P., *Hull.*

15.—1865 George Rolleston, M.D., F.R.S., Linacre Professor of Physiology in the University of Oxford, *Oxford.*

16.—1865 Cuthbert Collingwood, M.A., M.B., F.L.S., 4, *Grove-terrace, Belvedere-road, Upper Norwood, London, S.E.*

17.—1867 J. W. Dawson, LL.D., F.R.S., etc., Principal and Vice-Chancellor of McGill University, *Montreal.*

18.—1868 Captain Sir James Anderson, 16, *Warrington Crescent, Maida Hill, London, W.*

19.—1870 Sir John Lubbock, Bart. M.P., F.R.S., etc., *High Elms, Farnborough, Kent.*

20.—1870 Henry E. Roscoe, F.R.S., etc., *Owens College, Manchester.*

21.—1870 Sir Charles Wyville Thomson, F.R.S., etc., Professor of Natural History, *Edinburgh.*

22.—1870 Sir Joseph Dalton Hooker, M.D., F.R.S., etc.

23.—1870 Professor Brown Séquard, M.D.

24.—1870 John Gwyn Jeffreys, F.R.S., *Ware Priory, Herts.*

25.—1870 Professor Thomas H. Huxley, LL.D., F.R.S., etc.,4, *Marlborough-place, London, N.W.*

26.—1870 Professor John Tyndall, LL.D., F.R.S., etc, *Royal Institution, London.*

27.—1870 The Rev. Christian D. Ginsburg, LL.D., *Binfield, Bracknell, Berks.*

28.—1874 Professor Alexander Agassiz, Director of the Museum of Comparative Zoology, *Harvard, Cambridge, Massachusetts.*

29.—1874 Professor Frederick H. Max Müller, LL.D., *Oxford.*

30.—1874 Sir Samuel White Baker, Pasha, F.R.S., F.R.G.S., etc., *Sandford, Orleigh, Newton Abbot, Devonshire.*

31.—1877 Professor F. V. Hayden, M.D., etc., Director of the United States Geological and Geographical Survey of the Territories, *Washington.*

82.—1886 Alfred Higginson, M.R.C.S., 135, *Tulse Hill, London.*

83.—1877 Lord Lindsay, M.P., F.R.S., President of R.A.S., etc., 47, *Brook-street, London.*

84.—1877 Albert C. L. Günther, M.A., M.D., Ph.D., British Museum, Editor of the "Zoological Record."

85.—1877 Adolphus Ernst, M.D., Principal of the Department of Science, Philosophy, and Medicine, *Caraccas.*

86.—1877 Dr. Leidy, Academy of Science, *Philadelphia.*

87.—1877 Dr. Franz Steindachner, Royal and Imperial Museum, *Vienna.*

88.—1877 The Rev. H. B. Tristram, M.A., LL.D., F.R.S., Canon of Durham, *The College, Durham.*

CORRESPONDING MEMBERS.

LIMITED TO THIRTY-FIVE.

1.—1867 J. Yate Johnson, *London.*
2.—1867 R. B. N. Walker, *Gaboon, West Africa.*
3.—1868 Rev. J. Holding, M.A., F.R.G.S., *London.*
4.—1868 George Hawkins, *Colombo, Ceylon.*
5.—1868 J. Lewis Ingram, *Bathurst, River Gambia.*
6.—1869 George Mackenzie, *Cebu, Philippine Islands.*
7.—1870 Rev. Joshua Hughes-Games, D.C.L., King William's College, *Isle of Man.*
8.—1874 Samuel Archer, Surgeon-Major, *Honduras.*
9.—1874 Coote M. Chambers, *Burrard's Inlet, British Columbia.*
10.—1874 Edwyn C. Reed, *Museo Nacionale, Santiago de Chili.*
11.—1874 Millen Coughtrey, M.D., *New Zealand.*
12.—1875 Robert Gordon, Government Engineer, *British Burmah.*
13.—1877 Edward Dukinfield Jones, C.E., *Sao Paulo, Brazil.*
14.—1877 Miss Horatia T. Gatty, *Ecclesfield Vicarage, Wakefield.*
15.—1877 Dr. Allen, *Jamaica.*
16.—1877 Dr. George Bennett, *Sydney.*
17.—1877 Dr. David Walker.
18.—1877 Andrew Murray.

ASSOCIATES.

LIMITED TO TWENTY-FIVE.

1.—Jan. 27, 1862 Captain John H. Mortimer, "America." (Atlantic.)

2.—Mar. 24, 1862 Captain P. C. Petrie, "City of London," Commodore of the Inman Line of American Steam Packets. (Atlantic.)

3.—Feb. 9, 1863 Captain James P. Anderson, Cunard Service. (Atlantic.)

4.—Feb. 9, 1863 Captain John Carr (Bushby & Edwards), ship "Scindia." (Calcutta.)

5.—Feb. 9, 1863 Captain Charles E. Price, R.N.R. (L. Young & Co.,) ship "Cornwallis." (Calcutta and Sydney.)

6.—April 20, 1863 Captain Fred. E. Baker, ship "Niphon." (Chinese Seas.)

7.—Oct. 31, 1864 Captain Thomson, ship "Admiral Lyons." (Bombay.)

8.—Oct. 31, 1864 Captain Alexander Browne (Papayanni), S.S. "Agia Sofia." (Mediterranean.)

9.—April 13, 1865 Captain Alexander Cameron (Boult, English & Brandon), ship "Staffordshire." (Shanghai.)

10.—Dec. 11, 1865 Captain Walker, ship "Trenton."

11.—Mar. 28, 1868 Captain David Scott.

12.—Oct. 5, 1868 Captain Cawne Warren.

13.—Oct. 5, 1868 Captain J. A. Perry.

14.—Mar. 22, 1869 Captain Robert Morgan, ship "Robin Hood."

15.—April 29, 1872 Captain J. B. Walker, Old Calabar.
16.—April 29, 1872 Captain Alfred Horsfall, S.S. "Canopus."
17.—Oct. 18, 1875 Captain John Slack.
18.—Feb. 19, 1877 Nevins, Arthur B.
19.—Dec. 2, 1878 Captain C. A. Sibthorpe, S.S. "European."
20.—Dec. 2, 1878 Captain A. T. Cooper, P. S. N. Co.'s "Illimani."

VOLUMES PRESENTED TO THE LIBRARY DURING THE SIXTY-NINTH SESSION, 1879–80.

A.

American Association for the Advancement of Science, Salem, Mass. Proceedings, vols xxvi. and xxvii., 1877-8.

Ancient Buildings, Report of a Debate on the Restoration of. Notes and Queries Society, Liverpool, 1878.

Anthropological Institute, London. Journal, vols. viii and ix., parts 1 and 2.

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Arts and Sciences, American Academy of, Boston, U.S. Proceedings, vol. vi., 1878–9.

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Astronomical Society, The Royal, London. Monthly Notices, vol. xl., nos. 1–5. Memoirs, vol. xli.

B.

Birds of the Colorado Valley. United States Geological and Geographical Exploration of the Territories.

Botany. Journal, Linnæan Society. Nos. 101–105.

Botanical Society, Edinburgh. Proceedings, vol. xiii., part 3, 1878.

C.

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Coins and Medals, Notes on a Collection of, exhibited at Philadelphia, by Hy. Phillips.

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D.

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E.

Engineers, Institution of Civil, London. Proceedings, vols. lvi–lviii., 1879.

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F.

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G.

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Hymenoptera, New Species of. F. Smith, 1879. Presented by the British Museum.

I.

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Lettere e Scienze Morali e Politiche, Classe di. Reale Instituto, Lombardo, Milan. Memoires, vol. xiii., Fasc. 4, 1878.

Library, The Astor, New York. Reports, 1875–8.

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O.

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P.

Palæontologia Indica (4to.); Geological Survey of India, Calcutta. Series xiii., part 1, 1878;

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R.

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S.

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Silver Question, On the, by N. Pranden Berg, Liverpool, 1879.

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Z.

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List of Animals in the Society's Gardens, 1879.

Zoological Society, Philadelphia. Seventh Annual Report, 1879.

LIST OF SOCIETIES, ACADEMIES, INSTITUTIONS, Etc.,

TO WHICH THIS VOLUME IS PRESENTED.

(*The Asterisk denotes those from which Donations have been received this Session.*)

Aberdeen . . . . The Dun-Echt Observatory.
Alnwick . . . . *The Berwickshire Naturalists' Field Club.
Amsterdam . . . Der Koninklijke Akademie van Wetenschappen afdeeling Naturkunde.
Bath . . . . . *The Natural History and Antiquarian Field Club.
Belfast . . . . *The Naturalists' Field Club.
Belfast . . . . The Natural History and Philosophical Society.
Birkenhead . . . The Free Public Library.
Birkenhead . . . The Literary and Scientific Society.
Bombay . . . . *The Royal Asiatic Society.
Bordeaux. . . . La Société des Sciences Physiques et Naturelles
Boston (Mass.) . . *The American Academy of Arts and Sciences.
Boston (Mass.) . . *The Natural History Society.
Boston (Mass.) . . The Massachusetts Board of Agriculture.
Boston (Mass.) . . The Massachusetts Board of Education.
Boston (Mass.) . . The Massachusetts Board of State Charities.
Boston (Mass.) . . *The Massachusetts Board of Health.
Boston (Mass.) . . The Free Public Library.
Bristol . . . . The Naturalists' Society.
Brussels . . . . L'Académie Royal des Sciences, des Lettres, et des Beaux-Arts de Belgique.

Buffalo (*N.Y.*) . .	The Society of Natural Sciences.
Burlington (*Vt.*) .	The Orleans County Society of Natural Sciences.
Calcutta	The Asiatic Society of Bengal.
Calcutta	*The Geological Survey of India.
Cambridge. . . .	The Philosophical Society.
Cambridge. . . .	The Union Society.
Cambridge (*Mass.*) .	*The Harvard University.
Cambridge (*Mass.*) .	The Museum of Comparative Zoology.
Cambridge (*Mass.*) .	The Peabody Museum of American Archæology.
Cherbourg . . .	*La Société Imperiale des Sciences Naturelles.
Chester.	The Natural History Society.
Chester.	The Architectural and Archæological Society.
Chicago	The Free Public Library.
Christiana. . . .	The University.
Coldwater (*Mich.*) .	The Michigan Library Association.
Copenhagen . . .	L'Académie Royale.
Copenhagen . . .	La Société Royale des Antiquaries du Nord.
Davenport (*Iowa*) .	The Academy of Natural Sciences.
Dublin	The Royal Irish Academy.
Dublin	*The Royal Geological Society of Ireland.
Dublin	The Royal Society.
Edinburgh . . .	The Royal Scottish Society of Arts.
Edinburgh . . .	*The Botanical Society.
Edinburgh . . .	*The Meteorological Society of Scotland.
Edinburgh . . .	The Royal Observatory.
Edinburgh . . .	The Royal Physical Society.
Edinburgh . . .	*The Royal Society.
Edinburgh . . .	The Philosophical Institution.
Edinburgh . . .	*The Geological Society.
Falmouth	*The Royal Cornwall Polytechnic Society.
Geneva	La Société de Physique et d'Histoire Naturelle.
Gireswald	The University.
Glasgow	*The Philosophical Society.

Glasgow . . . . The Geological Society.
Göttingen . . . . Der Königlichen Gesellschaft der Wissenschaften.
Greenwich . . . . The Royal Observatory.
Haarlem . . . . Der Koninklijke Akademie van Wettenschappen.
Halifax . . . . The Literary and Philosophical Society.
Helsingfors . . . Der Finska Vetenskaps Societetens.
Hull . . . . . *The Literary and Philosophical Society.
Königsberg . . . Der Königlichen Physikalisch-ökonomischen Gesellschaft.
London . . . . *The Society of Arts.
London . . . . *The Royal Asiatic Society.
London . . . . *The Society of Antiquaries.
London . . . . *The Anthropological Institute.
London . . . . *The Royal Astronomical Society.
London . . . . The British Association.
London . . . . The British Museum.
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London . . . . The Clinical Society.
London . . . . The Royal Geographical Society.
London . . . . *The Geological Society.
London . . . . The Geologists' Association.
London . . . . *The Linnæan Society.
London . . . . *The British Meteorological Society.
London . . . . The Royal Society of Literature.
London . . . . *The Royal Society.
London . . . . The Royal Institution.
London . . . . The Statistical Society.
London . . . . *The Medico-Chirurgical Society.
London . . . . *The Institution of Civil Engineers.
London . . . . *The Royal Institute of British Architects.
London . . . . *The Royal Microscopical Society.
London . . . . *The East Indian Association.
London . . . . *The Zoological Society.
London . . . . *The Editor of "Nature."

London	*The Editor of "Quarterly Journal of Science."
London	*The Editor of "Science Gossip."
London	*The Editor of "Geological Magazine."
Leeds	The Philosophical and Literary Society.
Leeds	The Geological Society of the West Riding of Yorkshire.
Leipzig	Der Königlich-Sächsischen Gesellschaft der Wissenschaften.
Leicester	*The Literary and Philosophical Society.
Liverpool	The Architectural Society.
Liverpool	*The Historic Society.
Liverpool	*The Geological Society.
Liverpool	The Philomathic Society.
Liverpool	The Polytechnic Society.
Liverpool	*The Naturalists' Field Club.
Liverpool	The Microscopical Society.
Liverpool	The Chemists' Association.
Liverpool	The Numismatic Society.
Liverpool	The Royal Institution.
Liverpool	*The Free Public Library.
Liverpool	The Medical Institution.
Liverpool	The Lyceum News Room.
Liverpool	The Athenæum Library and News Room.
Liverpool	The Liverpool Library.
Liverpool	*The Powys-Land Club.
Liverpool	The Engineering Society.
Manchester . . .	The Literary and Philosophical Society.
Manchester . . .	The Free Public Library.
Manchester . . .	The Chetham Library.
Manchester . . .	The Owens College.
Manchester . . .	The Literary Club.
Melbourne . . .	The Royal Society of Victoria.
Milan	*La Reale Instituto Lombardo.
Munich	Der Königlichen Akademie der Wissenschaften.

Newcastle-on-Tyne .	Natural History Society.
New York	*The Astor Library.
New York	*The American Geographical Society.
New York	*The Academy of Sciences.
New York	The City University.
New York	The State University.
New York	The State Library.
New York	The State Museum of Natural History.
New Haven . . .	The Connecticut Academy of Arts and Sciences.
Otago	The University.
Ottawa	The Library of Parliament.
Oxford	The Ashmolean Society.
Oxford	The Union Society.
Paris	L'Ecole Polytechnique.
Penzance	*The Royal Geological Society of Cornwall.
Philadelphia . . .	*The American Philosophical Society.
Philadelphia . . .	The Academy of Natural Sciences.
Philadelphia . . .	*The Franklin Institute.
Philadelphia . . .	*The Zoological Society.
Philadelphia . . .	The Pennsylvania Board of Public Education.
Plymouth	*The Plymouth Institute.
Salem (Mass.) . .	*The Essex Institute.
Salem (Mass.) . .	*The American Association for the Advancement of Science.
Southport	The Literary and Philosophical Society.
St. Petersburg . .	L'Académie Imperiale des Sciences.
Stockholm	L'Académie Royale Suedoise des Sciences.
Strasburg	La Bibliothèque Municipale.
Strasburg	Die Kaiserliche Universitäts und Landesbibliothek.
Sydney	*The Royal Society of New South Wales.
Taunton	The Somersetshire Archæological Society.
Toronto	*The Canadian Institute.
Truro	*The Royal Institution of Cornwall.

Vienna	Der Kaiserlichen Akademie der Wissenschaften.
Vienna	*Der Geographischen Gesellschaft.
Whitby	The Literary and Philosophical Society.
Washington . . .	The Naval Observatory.
Washington . . .	The Department of Agriculture.
Washington . . .	*The Smithsonian Institution.
Washington . . .	*The War Office:—The Ordnance Department; the Office of the Chief Signal Officer, U.S. Army; the Department of the Chief of Engineers U.S. Army; the Department of the Paymaster-General U.S. Army; the Department of the Surgeon-General U.S. Army.
Washington . . .	*The U.S. Geological and Geographical Survey of the Territories.
Wellington, N.Z. .	*The New Zealand Institute.
York	The Philosophical Society.

TREASURER'S ACCOUNT, 1879-80.

Dr. *The Literary and Philosophical Society, in account with* R. C. JOHNSON, *Treasurer.* **Cr.**

				£	s.	d.
To Cash paid D. Marples & Co., Limited, Printing				164	7	9
" " Tinling, Circulars				12	3	0
" " G. G. Walmsley, Binding				7	1	0
" " Secretary's Expenses				15	19	0
" " " Editorial Fee				10	10	0
" " Doling, Refreshments				27	16	4
" " Burke, Attendance				1	15	0
" " Librarian's Expenses				4	0	5
" " Treasurer's "				1	2	4
" " Rent of Room				20	0	0
" " T. Kell, Map for Mr. Shoolbred's Paper				4	5	0
				268	19	10
Balance in hand, viz :—						
Dock Bond	150	0	0			
Cash	1	3	5			
				151	3	5
				£420	3	3

				£	s.	d.
By Balance from last Account—						
Dock Bond	£150	0	0			
Cash	19	3	1			
				169	3	
Cash received from Subscriptions :—						
25 Entrance Fees, at 10s. 6d.	13	2	6			
195 Annual Subscriptions, at 21s.	204	15	0			
18 Arrears, at 21s.	18	18	0			
5 Half Subscriptions at 10s. 6d.	2	12	6			
				239	8	0
Cash Interest on Dock Bond				6	12	2
Donation from Dr. Drysdale				5	0	0
				£420	3	3

Examined and found correct,

JAS. SIMPSON,
EDWARD DAVIES.

PROCEEDINGS

OF THE

LIVERPOOL LITERARY AND PHILOSOPHICAL SOCIETY.

ANNUAL MEETING.—Sixty-Ninth Session.

Royal Institution, October 6th, 1879.

JOHN J. DRYSDALE, M.D., M.R.C.S., President, in the Chair.

The Minutes of the last Meeting of the preceding Session were read and confirmed.

At the recommendation of the Council, the Meeting was adjourned to the 13th instant.

Dr. Hayward gave notice that he should propose at the adjourned Annual Meeting, the following alterations in Law 9:—That the words "not later than" should be substituted for the words "at or before;" and that the words "or his election will be void" should be omitted.

ADJOURNED ANNUAL MEETING.

Royal Institution, October 13th, 1879.

Rev. HENRY H. HIGGINS, M.A., Ex.-President, in the Chair.

The Minutes of the last Meeting were read and signed.

The reading of the Annual Report was deferred to the next meeting, at the request of the Honorary Secretary.

The Honorary Treasurer submitted the Annual Balance Sheet, and also an estimate of Income and Expenditure for the current Session. Both statements were duly approved and confirmed.

The following Office-bearers were then elected :—

Vice-Presidents—Thomas J. Moore, Cor. Mem. Z.S.L., J. Campbell Brown, D.Sc., &c., T. Higgin, F.L.S.

Hon. Treasurer—Richard C. Johnson, F.R.A.S.

Hon. Secretary—James Birchall.

Hon. Librarian—Alfred Morgan.

Council—New Members, nominated by the retiring Council—Wm. H. Samuel, Geo. F. Chantrell, C. H. Stearn, Rev. H. I. Johnson, M.A., Richmond Leigh, M.R.C.S.E. Nine Members of Council re-elected—E. Davies, F.C.S., G. H. Morton, F.G.S., W. Carter, M.D., Alfred E. Fletcher, F.C.S., I. Roberts, F.G.S., John W. Hayward, M.D., Josiah Marples, Rev. W. Stern, D.D., Baron L. Benas.

Mr. George Mackenzie, Cebu, Philippine Islands, was re-elected a Corresponding Member; and the Associates were also re-elected.

Dr. J. Campbell Brown then moved, on behalf of Dr. Hayward, who was absent, that Law 9 should be altered, according to the terms of notice given by Dr. Hayward. The motion was seconded by Rev. Dr. Stern. Its consideration was adjourned to the next meeting, and the new President then proceeded to deliver his Inaugural Address.*

* See page 1.

FIRST ORDINARY MEETING.

ROYAL INSTITUTION, 20th October, 1879.

EDWARD R. RUSSELL, PRESIDENT, in the Chair.

An Extraordinary Meeting was first held, when the Hon. Secretary read the following

REPORT.

The Council of the Literary and Philosophical Society has again the pleasure of congratulating the members upon the satisfactory position of the Society, upon its strength of numbers, and the character of its Proceedings.

The list of Ordinary Members continues to increase, the present roll containing the names of 256 members, being ten more than were reported at the beginning of the last Session. Eleven members have withdrawn during the last twelve months, and four have died, the names of the latter being Mr. Jas. Aikin and Dr. Vose, who had been connected with the Society for forty-six and thirty-five years respectively; Mr. Hugh Shimmin and Dr. Rickard. Twenty-five new members were elected during the Session.

Besides the Ordinary Members, the Society includes forty Honorary Members, nineteen Corresponding Members, and twenty Associates. Of these, the term of Mr. George Mackenzie, Corresponding Member, Cebu, Philippine Islands, has expired, and the Society will be called upon to consider his re-election.

The Society's financial affairs have occupied considerable attention on the part of the Council, and for the purpose of restricting the current expenditure within the limits of the current income, it has been resolved, "That in future, an

circle, were three mock suns. These were of about one-half the diameter of the true sun, and the inner half of them, nearest the sun, was dim and cloudy looking, but the outer half of each was brighter than the real sun, and from each proceeded outwards a bright pencil of light, converging to a point, at a distance a little less than half the radius of the halo. The effect was very striking and very beautiful, and as the phenomenon is one of great rarity, I have thought it worthy of being brought before the Society." He also exhibited a piece of lead pipe which had been gnawed through by rats, for the apparent purpose of obtaining water.

Mr. J. A. Picton, F.S.A., read some communications on the alleged showers of sulphur formerly reported to the Society.

Mr. Kerr exhibited some rare plants from the Fiji and other Pacific Islands, and a new Orchid from Central America. These and some other rare plants from the Botanic Gardens were described by the Rev. H. H. Higgins.

Mr. T. J. Moore exhibited selections from the following recent additions to the Free Public Museum:

An extensive collection of Marine specimens, consisting of Fish, Mollusca, Crustacea, Echinoderms, Zoophytes, Sponges, &c., collected between Liverpool, Sydney, Tuticorin, and Rangoon, and presented by Captain W. H. Cawne Warren, Ship "Bedfordshire," Associate of the Society.

Mr. F. P. Marrat exhibited selections from the Mollusca.

A series of Marine and other specimens collected during the voyage of the "Ennerdale" from Liverpool to Australia by Mr. C. E. Patterson, assisted by Dr. McAfee, and presented by Mr. C. E. Patterson.

An important series of Bowers and Bower-Birds, which is believed to be unrivalled. They were purchased from Mr. Waller, of Sydney, by whom they were obtained during

decessors, these agreeable reunions may bé regarded as an established part of the proceedings of all the Societies engaged, and requiring no further impulse from the Society which originated them.

The Council concludes its report with the recommendation of the following gentlemen for election on the new Council:—Mr. Wm. H. Samuel, Mr. G. F. Chantrell, Mr. C. H. Stearn, Rev. H. I. Johnson, and Mr. Richmond Leigh.

The Report was adopted, with the exception of the paragraph recommending the enactment of a Law asserting the Society's right of ownership in the papers read before it. The consideration of this question was deferred to the next meeting.

Dr. HAYWARD's proposal to alter Law 9, was, after some discussion, withdrawn.

The business of the Ordinary Meeting was then begun, and the Minutes of the Annual Meeting were read and signed.

Messrs. Charles McArthur, S. Veevers, Robert Gracey, F.C.S., and Thomas Mellor were elected Ordinary Members.

Mr. JOSIAH MARPLES described a recent appearance of Parhelia he had seen. "On Saturday, September 13th, 1879, while crossing the river from Egremont to Liverpool, between 8.35 and 8.50, we observed the very beautiful phenomenon of Parhelia or Mock Suns. The morning was hazy, and the sun was somewhat dimmed, so much so that it was possible to look at it without inconvenience. Around it was a halo, rather indicated than strongly marked, reaching from the horizon or below it to about 50° to 55° towards the zenith. The lower part of this was hidden, either by its being below the horizon or by the thick atmosphere of the town, but at the top and two sides of the halo, quartering as it were the

SECOND ORDINARY MEETING.

Royal Institution, 3rd November, 1879.

EDWARD R. RUSSELL, President, in the Chair.

Another Extraordinary Meeting preceded the holding of the Ordinary Meeting.

The President formally moved, on behalf of the late Council, the enactment of the law upon the proprietorship of papers read, as recommended in the Annual Report. He expressed, however, his dissent from the proposal. The motion was seconded by Dr. J. Campbell Brown, who strongly urged its adoption. After some discussion, the following amendment, proposed by Mr. Picton and seconded by the Rev. H. H. Higgins, was carried:—"That the proposed Law shall read as follows—Papers read before the Society are to be considered the property of the Society, for publication in its Proceedings, and no reader can withdraw his paper without the permission of the Council."

The Ordinary Meeting was then held.

Messrs. Emmanuel Faure and Daniel Dopson, and the Revs. Henry Varley and W. Luther Leeman were elected Ordinary Members.

Mr. Picton read a paper on "Money, Coin and Currency—Remarks on some recent fallacies connected therewith." *

THIRD ORDINARY MEETING.

Royal Institution, 17th November, 1879.

EDWARD R. RUSSELL, President, in the Chair.

An Extraordinary Meeting was again held to consider for the second time the proposed new Law, as adopted at the last

*See page 49.

Extraordinary Meeting. The amendment as then carried was now moved for confirmation by the President, seconded by Mr. Picton.

Opinions were still very much divided as to the necessity for making such a law, and ultimately the subject was referred back to the Council for further consideration, on the motion of Dr. Drysdale, seconded by Mr. Isaac Roberts.

At the Ordinary Meeting which followed, the Rev. Thos. Lunt was duly elected an Ordinary Member.

The President drew the attention of the Members to the recent announcement of the death of Professor Clerke Maxwell, and spoke of the heavy loss which the world of science had thereby sustained. In the course of his remarks he made special reference to Sir Geo. Airey, Sir Wm. Thompson, Stokes, Adams, Cayley, Sylvester, and Todhunter, who, with Maxwell, formed a brilliant band of Cambridge men who had raised their university to a height of distinction which had not been attained by any other in the world.

Mr. C. H. Stearn exhibited some experiments on the Phosphorescence of Gems and other Minerals in High Vacua.

Mr. Albert J. Mott read a paper on "The Nebular Theory." *

FOURTH ORDINARY MEETING.

Royal Institution, 1st December, 1879.

EDWARD R. RUSSELL, President, in the Chair.

The Rev. R. E. Long and Mr. Edmund Phipps Eyre were elected Ordinary Members.

* See page 139.

Dr. SHEARER exhibited specimens of Turk's Cap Cactus and other Cacti; and gave an account of a recent example of prolonged vitality in seeds. In 1877 a large cesspool in the garden of his house (157, Upper Parliament Street), built about fifty years ago, was removed and replaced by a proper drain. In the following summer a fine crop of from twenty to thirty scarlet pimpernels (*Anagallis arvensis*) sprung up, and was succeeded in the next summer (1879) by a second crop. No such flowers are to be found growing in the neighbouring gardens, and the only explanation Dr. S. could give of such an unusual sight was this:—That the seeds were buried in the soil where they grew when the neighbourhood of Parliament Street was a country suburb; that they were preserved in the sandy loam and stiff clay for fifty years, under the rubbish left by the builders of the house; and that in the construction of the drain they were again brought to the surface, and germinated.

The Rev. THOS. P. KIRKMAN, M.A., F.R.S., then read the first part of a paper "On the Simplest Possible Experiment in Physical Science—an Elementary Study in Philosophy without Assumptions." *

FIFTH ORDINARY MEETING.

ROYAL INSTITUTION, 15TH DECEMBER, 1879.

Mr. Stuart M. Johnson and the Rev. Robt. Stratten Holmes were elected Ordinary Members.

The HON. SECRETARY reported that the tickets taken at the doors on the evening of the Third Associated Soirée, held on the 10th inst., represented an attendance of 2,924 persons, and that the receipts exceeded £320. The balance in the hands of the Treasurer amounted to £64.

* See page 83

Dr. CARTER exhibited the nut of Anacardium, which produces a natural indelible marking ink.

The Rev. THOMAS P. KIRKMAN, M.A., F.R.S., then read the second part of his paper "On the Simplest Possible Experiment in Physical Science." *

SIXTH ORDINARY MEETING.

ROYAL INSTITUTION, 12TH JANUARY, 1880.

EDWARD R. RUSSELL, PRESIDENT, in the Chair.

Mr. STEARN exhibited an Incandescent Carbon Lamp, upon which he and Mr. Swan had been engaged for the last two years, and which had been in use months before the recent introduction of the Edison Lamp, and upon which he made the following remarks :—

INCANDESCENT CARBON ELECTRIC LAMPS.

BY C. H. STEARN.

A claim having been recently advanced by Mr. Edison to the invention of an electric lamp in which carbonised paper is rendered incandescent by the current, I cannot, in justice to my friend, Mr. J. W. Swan, of Newcastle-on-Tyne, allow the statement to pass unchallenged.

On Oct. 15th, 1877, Mr. Swan first mentioned to me that he had, at least fourteen years previously, kept strips of carbonised paper incandescent by a battery in the vacuum of an ordinary air pump, and although after some time disruption had occurred, he was satisfied that the subject was worth re-investigation, and invited my co-operation in a series of experiments on the durability of this carbonised paper in the more perfect vacua produced by the Sprengel pump.

* See page 109

From that time till now we have been engaged in the research, and tried various forms of lamp, using both carbonised paper, also thin carbon pencils, several of which I now exhibit in action.

I also produce a few of the carbonised paper strips that Mr. Swan left with me in 1877.

At a very early stage of our inquiry we found it absolutely essential that the residual gas occluded in the pores of the carbon should be removed by heating with the current before sealing off the lamp from the pump. When the vacuum is thus rendered permanent, and the contacts between the conducting wires and the carbon made perfect, little if any waste of carbon seems to occur; and if a longer experience shows that this absence of waste still continues, then, I think, the advantages of Mr. Swan's system of lighting will be found to be so great, that it must ultimately supersede most other forms of electric lamp, even if, as is asserted by many, there is a slight loss in the total of light obtained.

That Mr. Edison has arrived at his discovery of the advantages of carbonised paper quite independently, there is no reason to doubt; but to Mr. Swan, most unquestionably, belongs the merit of priority.

It seems to me that Mr. Edison has been rather precipitate in publishing his results, for though our experience of this method was long antecedent to his, we still think that further time is needed to test its durability before venturing on the positive statements that have lately appeared in the papers. Our experiments on various forms of the carbon conductor are still in progress.*

* *Note added while the volume is going through the press, Aug. 6th,* 1880.

Since the above communication was made we have found that a carbonised thread, prepared by a new process, gives better results, and is at the same time tough and highly elastic. This carbon wire, for such it may correctly be termed, can be made into spirals, thus increasing the quantity of light and the elasticity of the conductor.

The Rev. H. H. Higgins exhibited a small series of sections of Coal Plants recently added to the Free Public Museum, and mounted for examination with the microscope; also male and female examples of the large and beautiful Butterfly, *Ornithoptera aruana*, from New Guinea, collected and presented by the Rev. W. G. Lawes.

Mr. T. J. Moore exhibited a specimen of a recently-described Monotreme Mammal, *Echidna Lawesi*, Ramsay, also presented by the Rev. W. G. Lawes, by whom it was recently discovered in Southern New Guinea, making an important addition to our knowledge of these lowest of Mammalian forms, which were not previously known to exist out of Tasmania and Australia. The species was described and figured by Mr. E. Pierson Ramsay in the *Proceedings* of the Linnean Society of New South Wales, vol. ii., p. 32, pl. 1.

Mr. Isaac Roberts, F.G.S., gave an account of the present condition of Kent's Cavern.

The Rev. J. Sephton, M.A., then read a translation, with introduction and commentary, of "Eirik the Red's Saga." *

SEVENTH ORDINARY MEETING.

Royal Institution, 26th January, 1880.

JOHN BIRKBECK NEVINS, M.D., Ex-President, in the Chair.

Mr. Joseph Boult read a paper on "Topographical Traces of Ancient Assemblies and Courts in the British Isles."

* See page 183

EIGHTH ORDINARY MEETING.

Royal Institution, 9th February, 1880.

EDWARD R. RUSSELL, President, in the Chair.

An Extraordinary Meeting was first held to receive a recommendation from the Council with regard to the proposed new Law, referred back for the Council's consideration on the 17th November. It was now recommended that the law should stand as follows:—"The Society has the right to print in its Proceedings all papers read before it."

This recommendation was unanimously approved and passed *for the first time*, on the motion of the President, seconded by Mr. Guthrie.

At the Ordinary Meeting which followed, Mr. Chantrell exhibited a very rare specimen of a fresh-water Alga (*Coccochloris Mooreana*, Hassall), which he found floating on one of the lakes in Birkenhead Park. A microscopic examination of the specimen showed it to be densely covered with minute granules or germs, to which its colour is due.

Mr. Jas. T. Foard then read a paper on the "Life of Mr. Justice Story, Associate Judge of the Supreme Court of the United States." *

NINTH ORDINARY MEETING.

Royal Institution, 23rd February, 1880.

J. CAMPBELL BROWN, D.Sc., Vice-President, in the Chair.

The proposed new Law was again considered and unanimously confirmed, at an Extraordinary Meeting held previous to the Ordinary Meeting.

* See page 213.

At the Ordinary Meeting, Mr. R. C. Johnson, F.R.A.S., in answer to a question, communicated the most recent information on Double Stars.

The Rev. H. H. Higgins exhibited an extensive series of diagrams illustrative of Floral Defences, and contributed some curious information thereon.

Mr. T. J. Moore read the following note from Mr. E. Dukinfield Jones, C.E., Corresponding Member, dated São Paulo, Brazil, December 6th, 1879 :—

"When I was at Ypanema, in the Province of São Paulo, I made enquiries from the Manager of the Works there about the supposed new underground monster, noticed by the eminent naturalist, Fritz Müller, in *Nature*, for Feb. 21st, 1878, p. 325.

"Mr. Moore asked me to find out whether there was any foundation for the report. The '*bicho*' was said to be an *immense Earthworm*, over three feet in diameter, and none knew how long, that ploughed up great furrows and diverted the beds of streams.

"*The Manager said he never heard of any such 'bicho,'* * *or any other 'bicho' out of the common at Ypanema, and he has been there twelve years.*"

Dr. Drysdale then read a paper on a "Plan of a Self-acting Method of Regulating the Stock of Gold for the Paper Currency." †

TENTH ORDINARY MEETING.

Royal Institution, 8th March, 1880.

EDWARD R. RUSSELL, President, in the Chair.

Mr. W. H. Tickle was duly elected an Ordinary Member.

* *Bicho* is a general term for vermin.

† See page 287.

Dr. J. Campbell Brown exhibited and described a new substance invented by Mr. J. Berger Spence, of Manchester, and called Spence's Metal. It is a compound of polysulphide of iron, with excess of sulphur, which melts at 320° Fahr., and is admirably adapted for taking casts of medals or of statuary, both on account of its low melting point, and on account of its expansion at the moment of solidification. It resists alkalies and dilute acids, as well as acid air, and when cast on glass or a smooth surface, it has a high polish.

It has been used in London for filling the joints of iron pipes, and of iron railings, and the joint needs no caulking, and is more elastic than a lead joint.

The disadvantages attending its use are, that it must not be heated much above its melting point, otherwise it becomes viscid as sulphur does; and that at a higher temperature it takes fire and burns, so that a workman would have to be trained to avoid over-heating it.

The cost is rather less than lead, weight for weight, but less than one-third, bulk for bulk.

The Rev. H. H. Higgins read papers on "Life in the Lowest Organisms," illustrated with numerous drawings,* and on the "Plasmodium of a Myxomycetous Fungus." †

ELEVENTH ORDINARY MEETING.

Royal Institution, 22nd March, 1880.

EDWARD R. RUSSELL, President, in the Chair.

Mr. Morton, F.G.S., exhibited some interesting specimens of Sponge Spicules, found in the carboniferous limestone of Ayrshire.

* See page 251. † See page 270.

Mr. A. E. Fletcher, F.C.S., exhibited one of Hannay's artificially-made Diamonds, and described the experiments which led to the discovery of their manufacture.

Mr. G. F. Chantrell then read a paper on "Protoplasm," which was copiously illustrated by the author's own original microscopic drawings, exhibited by the lime light.

TWELFTH ORDINARY MEETING.

Royal Institution, 5th April, 1880.

Rev. H. H. HIGGINS, M.A., Ex-President, in the Chair.

Mr. R. C. Johnson, F.R.A.S., gave a summary of our present knowledge of the Comets, their orbits and periodicities, and also gave some special informatien of the anticipated appearance of the Southern Comet in the northern hemisphere.

Dr. J. Campbell Brown read a paper "On the Classification of the Chemical Elements, and Mendeleef's Periodic Law." Specimens of all the known elements were exhibited.*

THIRTEENTH ORDINARY MEETING.

Royal Institution, 19th April, 1880.

EDWARD R. RUSSELL, President, in the Chair.

Mr. Thos. Higgin, F.L.S., read a Preliminary Report on Specimens dredged up from the Gulf of Manaar, and presented to the Liverpool Free Museum, by Captain W. H. Cawne Warren, Associate of the Society, by Mr. H. J. Carter, F.R.S., with comments by himself.†

* See page 283. † See page 273.

The Rev. H. H. Higgins exhibited a remarkably fine and large specimen of the Giant Crab, *Macrocheira Kæmpferi* of De Haan, expressly procured from Japan, and presented to the Free Public Museum, by Mr. James C. Fraser. The specimen measures eleven feet from tip to tip of claws.

Mr. T. J. Moore read the following communications:—

NOTE ON THE OCCURRENCE OF THE SNOW BUNTING AND STARLING AT SEA.

By Capt. J. H. Mortimer, Associate, Ship "Hamilton Fish."

London, Nov. 14th, 1879.

I mail to your address to-day one of two little birds which paid me a mid-ocean visit, and which has been named by Mr. A. D. Bartlett, Superintendent of the Zoological Gardens, Regent's Park, as the Snow Bunting (*Plectrophanes nivalis*). It, with a number of its tribe, came on board Sept. 28, the ship then being in lat. 46° N., and long. 31° West; the nearest land at the time was the Azores, distance 420 miles, Greenland being about 840, and Iceland some 750 miles. There had been moderate weather for the week previous, as it was at the time, but 48 hours after a very heavy swell and sea occurred from the N.N.W., which was evidently caused by a northerly gale at some distance to northward of the ship, from which I inferred that the birds, which were quite numerous, had been blown off from Labrador or Greenland. They were captured by hand and by the ship's cats, and died on the decks, seemingly from exhaustion, though some were placed in cages and supplied with food and water.

From the frequent occurrence of flocks of land birds seeking rest and food on ships at sea, it may perhaps be fair to assume that great quantities perish from this cause.

About Oct. 10, when off the British coast, we encountered

an east wind of some strength and of two weeks' continuance, during which time we were visited by hundreds of Starlings (*Sturnus vulgaris*), who met, with some exception, the same fate as our previous feathery visitors. I may say that similar cases have frequently occurred to my observation during my long voyages.

NOTE ON THE OCCURRENCE OF THE LOGGERHEAD TURTLE (*CAOUANA*) AND THE LEATHER TURTLE (*SPHARGIS*) IN THE BAY OF BENGAL.

By Capt. W. H. Cawne Warren, Associate, Ship "Bedfordshire."

February 17*th*, 1879. *Position about the middle of the Bay of Bengal.* For a number of days previous, the sea had been as calm as a mill-pond, and not a breath of wind out of the heavens. This morning a lot of turtle were seen basking in the sun. We launched the boat and made for them, and by noon managed to capture a boat load, some of them 150 lbs., and others as low as 40 lbs. weight. I believe they were Loggerhead Turtle, being very like Green Turtle, except in the number of scales or shell-plates on the back, and more especially in the taste, as without sauce and other good things they were rather strong; still to men who have been fed on salt-beef for a long time they are a most agreeable change. When we got back to the ship from our morning hunt, I found all hands in a great state of excitement, having seen a very large turtle swimming near the ship. After refreshment we started again on another cruise. Just as we left the ship's side, the mate saw our turtle basking in the sun on the surface of the water; we then pulled towards him, and after several attempts got within a few yards. We then gently sculled up, when I managed to hook him well in the after-part. Then began the tug-of-war. The turtle made

most violent attempts to get off, and turned round and round in the water. Fortunately the line was spliced round the iron, and that allowed the hook to revolve in the splice like a swivel. By some means I got my leg through one of the bights of the rope. Rather than cut the rope and lose the turtle, I ran the chance of his hauling me out of the boat. We continued this revolving game for nearly a quarter of an hour; at short intervals the turtle would hang quiet for a few seconds. We managed to cut a hole through the soft part of the hind flipper, but before we could get a rope through the hole, the turtle managed to shake himself off the hook and dived down. The water being very clear, we could see a long distance down, and we followed up in the boat. After a short time the turtle came to the surface again, and just as he came up made quite a leap out of the water, and at the same time uttered a cry of pain or groan. I then let fly the grains, which, rebounded off his back like off indiarubber, when down he went again. Next time I aimed the grains more at the edge of the animal, where they held for some time. We again tried to get a rope fast to his flipper, but we again lost him. The next time we broke the grain staff. We then sharpened the staff like a spear, and started after him again; and we kept this up for quite an hour-and-a-half. The turtle at last made a dive down, and we never saw him more. By this time we were well blown and gladly rested from our labours; all the while keeping a good look out for our friend, but to no purpose. I should think this turtle was rather over nine feet in length, and about five to six feet broad. What the weight would be I could hardly say, not less than half-a-ton, I should think. It is the first and only turtle of its kind I ever saw. The back was fluted or in ridges from the head towards the tail, and *covered with barnacles and tubercles.* It had no scales, but the hide appeared like leather. The fore-legs or flippers

appeared to me to be very long, more so than in the common turtle. The colour was a dark slaty brown, with *numerous white spots.*

[NOTE.—The description given at the close of the above letter proves the creature to have been an example of the Leather Turtle, the largest species known, and though widely distributed, rarely met with. The following extract is from Dr. Gunther's *Reptiles of British India*, published by the Ray Society, 1864, p. 55:—

"This Turtle, although scarce, appears to be spread throughout almost all the seas of the tropical and temperate regions, having been found in the Mediterranean, on the South Coast of England, in the West Indies, at the Cape of Good Hope, on the coasts of the United States, in Chili, and in Japan. Its occurrence in India has been recorded by Major S. R. Tickell, who gives a very interesting account of the capture of a female specimen on the coast of Tenasserim.

"'She was captured Feb. 1st, 1862, near the mouth of the Yé River, on the sandy beach of which she had deposited about a hundred eggs, when she was surprised by a number of Burmese fishermen, who had been lying in ambush near the spot (a favourite resort of the common turtle, *Chelonia virgata*), and after a desperate struggle was secured. Her entire length was six feet two and a half inches.

"'The strength, aided by the enormous weight of the animal, was such that she dragged six men, endeavouring to stop her, down the slope of the beach almost into the sea, when she was overpowered by increased numbers, lashed to some strong poles, and brought into the village by ten to twelve men at a time.

"'It is of exceedingly rare occurrence. The few that have been seen were on the shores of the numerous islands along the coast. This was the first one ever found on the mainland.'"

Captain Cawne Warren may, therefore, feel some consolation for not securing his larger specimen under less favouring circumstances (his boat's crew numbered, I believe, only two others beside himself), and from the fact that the flesh of the captured one proved to be so dark and coarse that very few of the crowds of Burmans assembled at Yé to see the animal would eat any of it!

The Liverpool Museum is fortunate in possessing a fine stuffed specimen, as well as a skeleton, of this species from the West Indian Seas.—T. J. MOORE.]

NOTE ON A PLAGUE OF AUSTRALIAN RATS, AT WARREGO RIVER, QUEENSLAND.

By Mr. Frederick Armstrong.

We have just got rid of a "Plague of Rats," and a species of Hawk that accompanied and preyed upon them. About six months ago, we found these rats in incredible numbers all over the vast plains of the Warrego, where they burrowed in the soft soil, or made nests in the dwarf salt-brushes with which the plains are thickly covered. These vermin were soon found a great nuisance, by the destruction they caused in rations, saddles, etc., etc., and although we "legislated" against them, and introduced cats, and scattered poison with a liberal hand, still the nuisance was unabated. Things had been going on like this for about five or six months, when the rats having, I suppose, fulfilled their mission, whatever that may have been, disappeared, as did also the hawks and owls. The rats and owls have not appeared here since, but the hawks have come at times in small numbers. The plumage of these hawks, on the breast and on the under parts, is pure white, the back light grey, and the shoulders pure black. They spend the greater part of their time on the branches of the dead pine trees, on which they pack themselves so closely, that, at a distance, with their breasts turned to you, the branches look as if covered with snow. They are generally very sluggish and inactive, and will sit for hours motionless. I have often seen the little black boys knocking them off on one side of a tree with their boomerangs, whilst those on the other side remained perfectly still, and apparently quite unconscious of danger. I have frequently fired amongst them with a rifle, killing three or four at a shot, and the others have not stirred. At a certain hour of the afternoon they take to the wing, and, by a series of circles, rise to a great

height, until their white breasts become mere specks in the blue sky. After circling about at that height for some time, they descend in the same manner and resume their perches, where they sit until dusk, when they will fly out on the plain, and may be seen hovering about like sea-gulls, and every now and then pounce down upon a rodent, which they devour whilst on the wing. By sunrise they are all on their accustomed places. They must have killed great quantities of rats, for the ground beneath the trees where they camped was thickly covered with fur, which they, like the owls, have the power of ejecting from their mouths. Yet, notwithstanding dingoes, hawks, owls, cats, and poison, there was no perceptible diminution in the number of rats for some months, when all at once they greatly decreased, as did the hawks; and about two or three weeks ago there was neither rat nor hawk to be seen, and the rats have not appeared since. Where have they gone?

Thurulgoona, Warrego River, Queensland,
October 6, 1879.

[NOTE.—The Hawk spoken of by Mr. Armstrong is evidently a species of *Elanus*, of which Gould figures two species in his "Birds of Australia"; one discovered by him, and named *scriptus* (from the letter-like prolonged black bar under the wing), which Captain Sturt found "abundant at the Depôt towards the interior of Australia"; the other, *axillaris*, with an oval spot of jet black beneath the shoulder, which species is reported by Gould as widely and thinly dispersed. There is no character given by which the Owl or the Rats may be identified, several species of both being native to Australia, the Rats being true Rodents.

The multitude of rats, so great as to be quite fairly called a plague, was possibly due to the exceptional abundance of some attractive food. At any rate, similar instances of swarms of rat-like rodents have been recorded, and definitely thus explained, in recent numbers of "*Nature*" for 1879 (*e.g.*, in Brazil, No. 498, p. 65; in Ceylon, No. 507, p. 267; in Chili, No. 518, p. 530); some of which recur at intervals of several years, dependent on vegetable phenomena.—T. J. MOORE.]

NOTES ON LEPIDOPTERA OF SÃO PAULO, BRAZIL.

By E. Dukinfield Jones, C.E., Corresponding Member.
Plates 1 and 2.

(In a letter to Mr. T. J. Moore, dated São Paulo, Brazil, 10th March, 1880.)

"When I wrote you last I had noted about 84 caterpillars, worked out 41 metamorphoses, and captured some 290 perfect insects. At the present time my list shows 117 species of larvæ, 58 metamorphoses, and nearly 350 imagines. You will observe that the number of perfect insects has not grown much during the year, but the caterpillars and the work in metamorphoses are quite up to the mark.

"Amongst the species whose changes I have observed during the past year are some very interesting ones. They include 6 Bombycidæ, 5 Noctuidæ, 1 Sphinx, 2 Papilios, 1 Junonia, 1 Agraulis (*A. vanillæ*).

"Amongst the Bombycidæ is a very handsome Attacus, and I have another Attacus whose metamorphoses I know, but not having 'worked it through,' I do not yet include it in my series. It is a magnificent species, expanding six inches, and is very beautifully marked.

CANNIBALISM IN THE LARVAL STATE OF CERTAIN NOCTUIDÆ.

"There are some very beautiful species included in the five Noctuidæ, and one of them is interesting from its habits of cannibalism in the larval state. The following is taken from my notes :—

"Jan. 11th, 1880.

"This morning, while collecting caterpillars, I was surprised to see two of one species devouring a third of another species. The eaters (Larva No. 97) are at present 25 to 30 millimetres in length, and about 4 millimetres in diameter, and are of a species that has lately appeared in great quantities

in the neighbourhood of São Paulo. They feed on *capim* (a kind of grass grown for feeding cattle). I have also found them on maize and cabbage. In many places there is a regular plague of these caterpillars, and they are doing great damage in the gardens. The victim was a caterpillar of about the same length, but much thicker (No. 98). When I first observed the occurrence, the unfortunate victim was half eaten, though still alive, and his devourers were feasting upon his entrails. Thinking this a very remarkable case, I introduced another caterpillar (No. 98) into my collecting box, and in a few seconds he was seized by one of the others and cut in the abdomen, so that at the first bite his 'inside' began to come out. He writhed about and attempted to bite his antagonist, but all in vain, and in a short time he was helpless, and allowed the others to eat him. The cannibals eat their victims in the most voracious way, wallowing in their juices and gorging themselves with the carcases. I repeated the experiment four times, and always with the same result; as soon as ever one of the doomed ones happened to touch one of the others, he was seized and devoured. Once or twice the attacked was able to shake off his adversary before he had time to get a firm hold; but in the long run he would inevitably be devoured.

"On one occasion a savage seized upon one of his own species, and they had a pretty good fight; ultimately they separated, however, one of them retiring with considerable wounds. It is remarkable that two caterpillars whose food-plants are the same should be such enemies.

"I was unlucky in rearing the perfect insect from the cannibal larvæ, only one arriving at maturity, and it unfortunately escaped.

METAMORPHOSES OF A PAPILIO.

"One of the Papilios I have reared is very curious, the pupa being of a remarkable form, and being attached to the

twig of the tree (*Rollinia ?*) on which it feeds, so as to resemble a fruit.

"Enclosed is a pen-and-ink outline of the larva, pupa and imago, xlii. of my series. (See Plate 1.)

"The caterpillar is marked with indistinct longitudinal stripes of black and brown, a very dull blue narrow stripe in the centre; a white or pale cream-coloured strap crosses two of the segments. It possesses the usual scent organs on the first segment, of a dull orange colour.

"The chrysalis is of a beautiful pale green, with a small brown dot at each side, and a row of dots of the same colour more or less connected in a string along the curious protuberance on the back of the thorax.

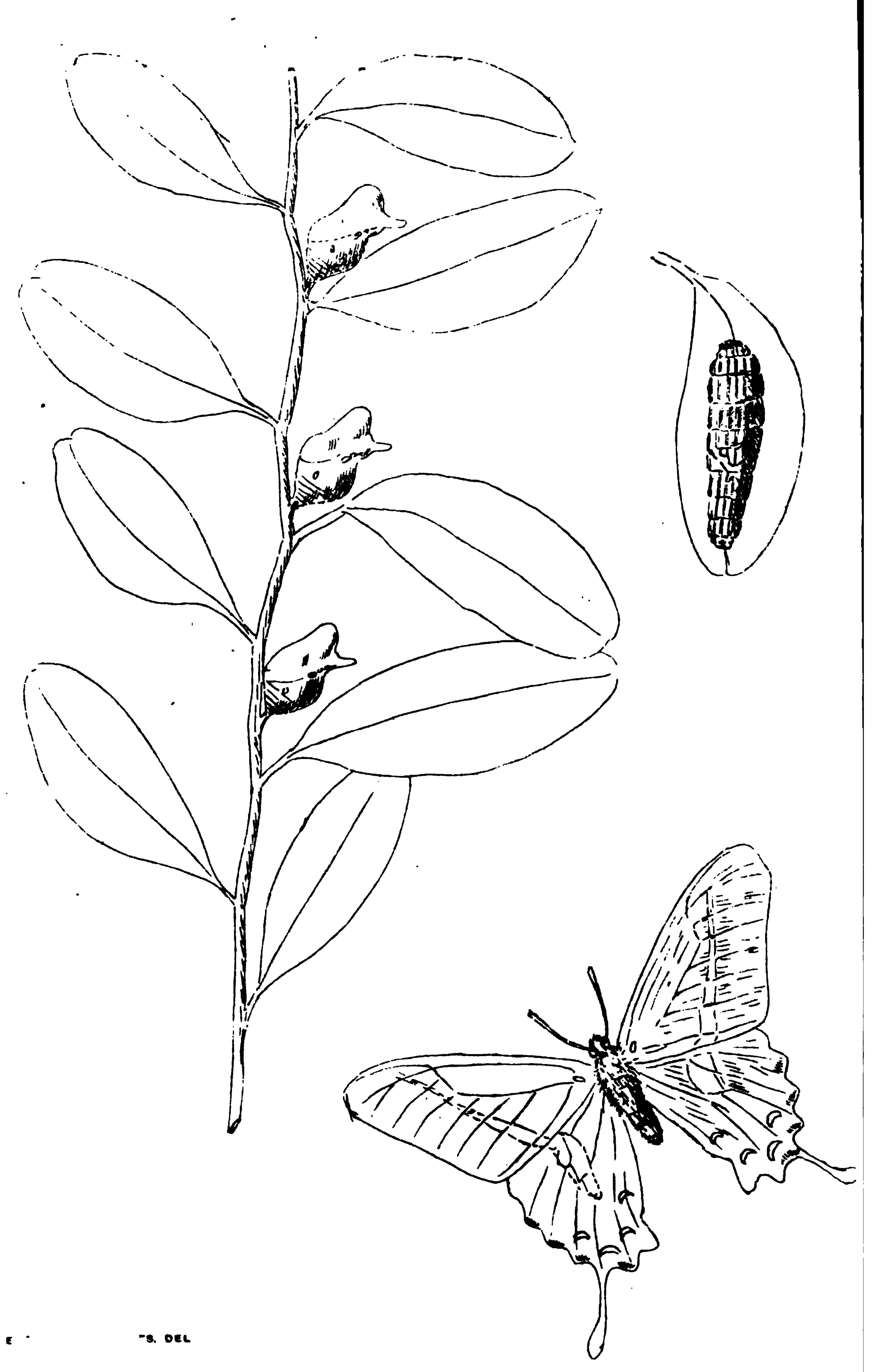
"The butterfly is black, with a white stripe or band from near the apex of the anterior to the middle of the posterior wings. Four crimson half-moons ornament the posterior wing, and a tiny spot of the same colour occurs close to the base of the discal cell. The species does not appear to be very common, though one closely allied is one of the commonest of the São Paulo butterflies.

"It is remarkable that the time this species remains in the pupa state should be so variable; my first specimens remaining from October to February, and the others from the 4th to 22nd of January only. If the longer period had been during the cold season, I could have understood it better. But the longer period takes place during the hot season, and actually includes the shorter. *

HABITS OF OIKETICUS ON LEAVING THE EGG, AND MODE OF FORMING ITS CASE.

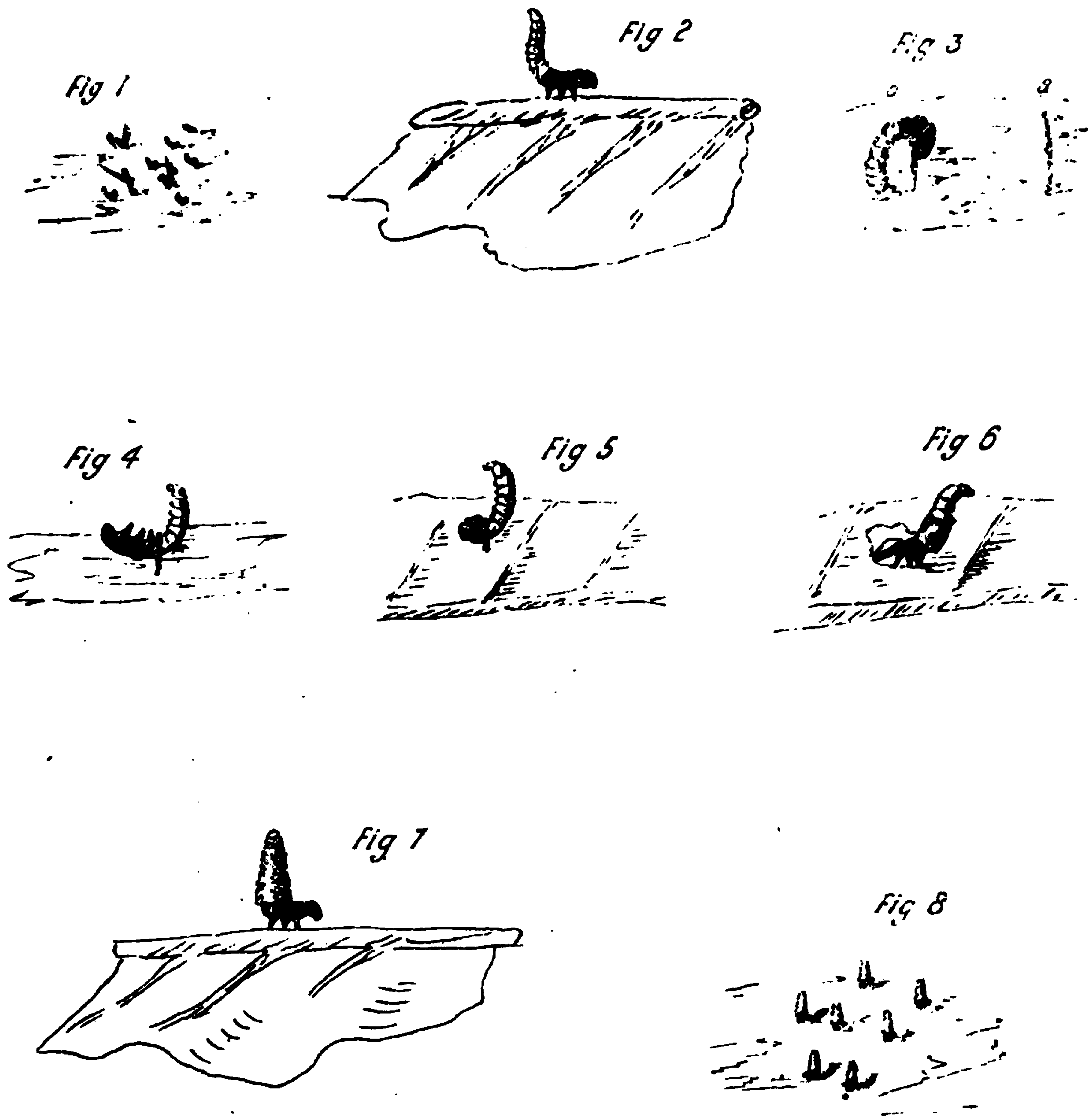
"The most interesting thing I have to communicate, however, is an account of the habits of the *Oiketicus* on leaving

*Specimens full fed, 9 Oct., 1878.	Specimens full fed, 4 Jan., 1880.
Imago, 24 Feb., 1879.	Imago, 22 Jan., 1880.
Pupation, 138 days.	Pupation, 18 days.



E - -S. DEL

PLATE I



DUKINFIELD JONES, DEL.

OIKETICUS sp.

Fig. 1. Young larvæ just emerged from eggs (slightly magnified).
Fig. 2. Young larva just emerged from egg (much magnified).
Fig. 3. (*a*) Band of silk and pieces of leaf attached at each end to surface of leaf.
Fig. 3. (*b*) Larva in the act of turning "head over heels" through the band.
Fig. 4. Larva at the close of above operation.
Fig. 5. Larva in the act of adding material to the band.
Fig. 6. Larva with case half finished.
Fig. 7. Larva with case finished.
Fig. 8. Larvæ with cases finished (magnified about 2 diam^s.)

PLATE II.

the egg, and the mode of beginning the case in which it spends its life.

"The eggs are laid within the shell of the pupa, and remain within the suspended case till they are hatched. The young caterpillars swarm out of the other end of the case in hundreds, and let themselves down a few inches by webs, which together form quite a thick mass. They are most comical objects, running about with their 'tails' up in the air, reminding one forcibly of devil's coachmen (*Staphylinus*), Plate 2, Fig. 1 and Fig. 2.

"In January, 1878, I had a brood of the caterpillars from the case I had found in December. When I found the little fellows tumbling about all over my table, I strewed some leaves about, and in a few hours many of them had made jackets for themselves of the epidermis and hairs of the leaves. The next day hundreds of the tiny caterpillars were pouring out of the eggs, so I hung up the case in its natural position to a twig of the shrub on which I had seen the species feed, expecting that they would at once begin to make themselves cases from the leaves. Instead of doing this, however, they let themselves down as described above, and remained suspended in the air. In moving the branch across the open door of my room, the little caterpillars were caught in the draught. Directly they felt the wind, they threw out lines as quick as thought, and were borne away on these, until, in a few moments, not one was left. After some hours, during which the *Oiketicus* case had remained quite still and protected from the draught, there was another army of little grubs ready to disperse. I took them to the door, and away they went just as the others had done. The line is as light as gossamer, and the caterpillars float away on it just as gossamer spiders do.

"On repeating the experiment a few days later, when another brood of young ones was hatched, the result was

exactly the same. They seemed to melt away with the air, and soon not one remained.

"On January 17th, 1880, another brood was hatched, and they behaved in every particular as those described above. I determined to watch them carefully, and see, if possible, the way in which they set about making their jackets. After some time, I observed one little fellow on a guava leaf, who seemed about to begin operations, so I brought my lens to bear upon him and watched him.

"The first thing is to cut about a dozen or so of bits of the epidermis off the leaf, which pieces are carefully collected and kept together by the legs of the insect. Then, when a sufficient quantity is ready, they are bound together in a string with silk, and the string thus formed is fastened to the leaf at each end, leaving it free in the middle (Fig. 3*a*). The caterpillar then 'turns head over heels' (Fig. 3*b*) through this loop, till the thorax is on one side and the abdomen on the other (Fig. 4). Then, with the mandibles, the loop is cut from the leaf at one end and bound round the body, still leaving it attached to the leaf at one point. Then the cutting of material is resumed, and each time a piece is cut it is placed on the thoracic side of the girdle (Fig. 5), and bound there with silk. After a while the girdle is loosened from the leaf, and the increase of the case is carried on with great order and regularity. The workman-like way in which the little creature does his work is very striking. As the girdle grows in width it is gradually pushed backwards towards the 'tail' (Fig. 6), and always increasing slightly in diameter, it after a while forms the conical case which is the foundation of the house which is to protect the caterpillar all his life (Figs. 7 and 8). It appears to take from two to three hours to complete the cone.

"Later on in life the species I have been describing binds pieces of stick into its case, and when full fed the case is

about two-and-a-half inches long, and five-eighths of an inch in diameter at the widest part. The mode of binding the pieces of stick into the case is very curious.

"In Dec., 1879, I was fortunate enough to observe one in the act. The stick in question, in this case the mid-rib of an orange leaf, was trimmed by the mandible to the desired size, being held by the front legs for this purpose. The case was first securely fastened to a twig by one side of the baggy mouth. The caterpillar was thus quite at ease, and had all his legs at liberty for building purposes. When the bit of stick was prepared to his satisfaction, he half closed the mouth of the bag, and then fastened the stick lightly to it with one or two threads of silk. Then he drew right into the case and closed the mouth completely. The next thing I observed was that he was poking about just where the loose bag joins the already firm part of the case, and very soon I found he was cutting a hole through the bag. In a few seconds his head appeared through the hole he had made, and he pushed out till he could reach the stick, which he then seized in his jaws and pulled loose. The head was then pulled back through the hole and the stick brought to the spot. It was then bound with silk on the inside of the case, and would be afterwards covered with silk on the outside as well. It thus becomes completely woven into the texture of the case.

"I hope that during next session of the Literary and Philosophical Society, I shall be able to send you some further communications of interest."

The Rev. W. H. Dallinger then read a paper on "Life Histories and their Lessons—a Defence of the Uniformity and Stability of Vital Processes, as controlled by the Laws of Evolution," illustrated with transparencies drawn from Nature by the Author.*

* See page 301.

THE PLACE AND POWER OF CRITICISM.

By EDWARD R. RUSSELL.

A SPIRIT of egotism is not that in which a President of our Society should deliver his first address from this Chair. But I hope it may savour rather of humility than of conceit to offer to you some remarks on a subject in which, from my personal experiences and associations, I am deeply interested, and on which your kindness in raising me to this position has led me to meditate anew.

I propose to speak to you of the Place and Power of Criticism; and, although I shall not be unnecessarily apologetic, much of what I have to say will be intended to vindicate a branch of Literature and Philosophy which appears to me to be under valued, and insufficiently cultivated.

Of those who hear me announce this theme, some will say I am undertaking an unnecessary task. Others will think I am attempting a hopeless one. On the one hand I shall be assured that good Criticism of all sorts is justly esteemed. On the other I shall be warned that it is fruitless to endeavour to excite any enthusiasm on behalf of a species of literary effort which is always of secondary and commonly of no importance. In this incidental conflict of judgments I find my justification for endeavouring to make out my case.

And when I say my case, there is a special and particular significance in the personal pronoun. You have elected to the Presidency of this Society, filled in the past by so many distinguished men, one who, since his pen had any pith, has employed it uniformly in Criticism—one who confesses, and of whom it is well known among those who gave him their suffrages, that he has scarcely written a line or attempted a stroke of creative work—one who not only acknowledges this,

but advances it as the modest boast that best becomes him; but who believes none the less in the creative power of the critical craft and of critical appreciation. I feel entitled by the honour that has been conferred on me to assert the Place and Power of Criticism, and to admonish its depreciators that they are probably destitute alike of the critical faculty, and of any just apprehension of the work it has done.

But it is not my intention either exactly to define or to lay down rules for Criticism. This has always been found a mere waste of time and thought, and an opening of the sluices of vexatious controversy. I wish to exalt the function and the promise of intelligent Criticism on the merits, without attempting to say minutely what Criticism is, or definitely what type of Criticism is intelligent, or, at all, what are the merits upon which Intelligent Criticism should pronounce. Criticism has no rightful place and ought to have no actual power of an arbitrary or autocratic character. Its virtue lies in the judicial energy of well-informed and rightly-balanced minds, and cannot be more closely described, although it is quite possible to debate hotly and idly wherein true Criticism consists, and how it should be brought into play.

As a matter of form it may be necessary at the outset to disown any intention to discuss Criticism in one or two other aspects which will occur to many minds. For a long time Criticism had a very narrowly limited meaning; and even now, both here and in Germany, a literary critic is commonly understood to be one of those microscopic students who, if they arrive at important conclusions, do so by means of the minutest observations. The Criticism for which I speak, however, is not the Criticism of a Scaliger or a Bentley, nor the Criticism which has lately founded theories upon the line-

endings and other structural peculiarities of Shakspeare's verse. I use the word in a larger and higher sense, as denoting the faculty and occupation of the mind by which the merits of literature, art, affairs, and conduct are systematically judged, and by which the judgments so passed are presented in literary form to the world. To this faculty, and to the mind when so occupied, Criticism, in its narrower and drier sense, is only one of many ministrants. Occasionally the observations which it makes arrive at a degree of approximate certainty which exacts for them the acceptance of the higher critic. For instance, we can conceive a Shakspearian or classical critic so clearly establishing that a certain phrase could not have been used by its reputed author that the convictions of one who judged of authorship by style and thought might be overborne. But the thing written would remain, whoever wrote it; and cases must be very rare in which the minute corrections or *apercus* of verbal Criticism or profound scholarship can affect the complexion or the worth of those noble treasures of which true Criticism is the custodian and the expositor.

Another repudiation necessary to be made, in consequence of certain gratuitous and arbitrary definitions of Criticism enunciated by one of the finest living critics, is this:—While acknowledging most freely that Criticism is an endeavour to learn and propagate the best that is known and thought in the world, I dispute the appropriateness of Mr. Matthew Arnold's qualification when he calls it a "disinterested" endeavour, and explains that in his judgment true Criticism is essentially the exercise of "curiosity as to ideas and all subjects, for their own sakes, apart from any practical interest they may serve." "Criticism," Mr. Arnold says, "obeys an instinct prompting it to try to know the best that is known and thought in the world, irrespectively of practice, politics, and everything of the kind, and to value knowledge and

thought as they approach this best, without the intrusion of any other consideration whatever." I have no objection to abstract Criticism, or to Criticism on grounds of pure taste, and I fully recognise the danger of valuing productions of imagination by a didactic standard; but it seems to me that the moral, social, or intellectual utility which obviously attaches to many works, especially of literary art, must enter largely into any adequate critical estimate, and that there are not many really great works of any kind which would not rank all the higher for having their broader and collateral utilities thus brought into the reckoning.

Criticism, no doubt, should always be historic in spirit, whether employed upon ancient or modern work, and it is an offence both against taste and against truth to read into any work more meaning than is consistent with its time and the circumstances which surrounded its production. But it does not follow that the intention of the author is to be the measure of his work's significance. A recent newspaper writer has asked, with much pertinence, whether we are to regard as priggish or mistaken all art that tends to elevate the moral nature of man, and has found his best answer in the works of Shakspeare, of Homer, of Dante, and of Scott. "It is life itself," he says, "that meets us in their poems; life, with no feature omitted and none caricatured. They have no intention to teach and no fear of teaching, but show us the world in a strangely new, vivid, and impressive way. Consequences, in their art, must of necessity follow hard on actions, and hence the lesson of the lives they tell of comes home more swiftly and more surely than in the life of the world around us. But the lesson is never thrust forward, because it did not hold more than its proper place in the mind of the singer; because it did not hide slight incidental matters of sorrow and laughter from the vision of the seer." This is a beautiful and accurate discrimination. We discern in it

both the permanent verity of the moral laws to which even art must yield tribute on pain of sterility, and the invariable conditions of dramatic and lyric production in which ethics cannot have too prominent a function on pain of artistic futility. But it is none the less a gross mutilation of Criticism to curtail it of its fair moral proportions. There are ethical and even theological significances pervading consistently, though faintly, some of Shakspeare's plays. They add to the power and interest of those plays, without derogating from their singleness of artistic purpose. It cannot be from the purpose of Criticism to trace and indicate, or even to postulate, these subtle meanings. Even if we are to judge of all art apart from all practice, we may be forgiven these delicate botanisings, although against the rude and wholesale mowing and stacking of moral influences it is no doubt fit and right to protest in the name of Art.

But I venture to go farther, and to plead for the actual and usual productiveness of Criticism as Criticism, without reference to the subjects upon which it is employed. It is not the sole business of Criticism to arraign or to descant upon works of art. Criticism is just as much within its province, and has the same quality of fruitfulness in dealing with the fallacies of common reasoning, with the incidents of public life, with the conduct of public affairs; in fact, with all settled and deliberate efforts of the human intellect. And in its application everywhere, whether to art, to literature, to oratory, or to life, it will be found not only to conduce to the formation and maintenance of sound judgments, but to the actual evolution of ideas and impulses. It is this property and function of Criticism that is so little understood. As it depends upon the natural action of competent and fruitful minds in criticising, and not upon the occupation of those minds with this or that subject, we need not systematically follow its action through the various departments of human

thought and judgment. We can content ourselves with general views.

Mr. Ruskin has exquisitely said that "Poetry is the suggestion, by the imagination, of noble grounds for noble emotions." A very acceptable definition of Criticism would be the *discernment* of noble grounds for noble emotions, and of righteous grounds for righteous disapproval. In the latter department justice requires that fact and a fair standard should be rigidly adhered to. In that of encomium, or appreciation, there is a legitimate, or, at least, a permitted place for fancy. Criticism may discern a beauty that is not, and there may be no harm done. But whether the beauty which is proclaimed exists or not, Criticism earns our thanks if there was any likelihood of its being overlooked. When "noble grounds for noble emotions" have been critically discerned, we are bound, in justice to Criticism, to ask, Are these noble grounds for noble emotions generally perceived where Criticism has found them? Are these noble emotions generally felt to the full without critical prompting by those to whom critical writings are likely to appeal? If not, can critical disquisitions arouse and excite these noble emotions? Would such emotions, springing out of appreciation, be more general if the critical faculty were more commonly and assiduously cultivated? And, finally, would any literature, other than critical, yield us the many added, imagined, suggested conceptions which Criticism produces?

It being understood that the Criticism of which I am the apologist consists in apprehending and interpreting the merits of art, literature, and conduct, the qualities requisite in the critic, beyond the necessary amount of knowledge, are these: efficient common sense—to use a phrase which I have employed before, and with which I cannot dispense—and sympathy. Efficient common sense is not infallible, but it is

nearly so—as nearly as human faculties can get. In fact, if I were disposed to play upon words, I might say that where common sense is not infallible it is not efficient. Even taking efficient in a fair and natural sense, so as just to distinguish the common sense of which we are speaking from the rude and ignorant dogmatism which frequently usurps its name, we may say that the common sense of fairly cultured men, who are on their guard against prejudice, is seldom betrayed into error. Often enough superior technical knowledge presumes to depreciate the conclusions of a common sense which is not so minutely informed about details; but such depreciations are seldom valid or even relevant. Efficient common sense is a much rarer quality than technical knowledge, and is entitled to regard many minutiæ of accuracy with indifference, when propounding the purport or the purpose of anything worthy of serious Criticism. Sympathy is more essential. Common sense is apt to be hard in the absence of an instinct which seeks out and associates with the critic's feelings the aim which gave pleasure and animation to the author of the work; and the sympathy which, on the one side, enters into the feelings of the author, and, what is more to the purpose, into the soul of his production, should, on the other side, yearn towards the whole world of sentient intellect by whom that production is capable of being enjoyed.

One of the few writers who have thought it worth while to treat elaborately of Criticism has reminded us how Wordsworth, in a celebrated preface, proved to his own satisfaction that the most palpable stamp of a great poem is its falling flat upon the world, to be picked up and recognised only by the fit and few. "But," says this writer, "the two seldom go together. The fit are not few, and the few are not fit. The true judges of art"—this is putting it strongly, but there is a truth in it—"are the much-despised many—the crowd—

and no critic is worth his salt who does not feel with the many."

Equipped with efficient common sense, and with the twofold sympathy of which I have just spoken, the critic enters upon his avocation. But, as he proceeds, the labour which only offers to be useful may become glorious.

> Sunt, quos curriculo pulverem Olympicum
> Collegisse juvat, metaque fervidis
> Evitata rotis palmaque nobilis
> Terrarum dominos evehit ad Deos.

It is not always, however, by intention or within the strict course of his comparatively humble duty, that the critic achieves his greatest triumphs. As an honest rider he keeps within the ropes, and ambles or trots rather than gallops, observing the paces and the achievements of the noble steeds it is his business to admire or censure, but he sometimes bestrides the eager barb Imagination, and is borne swiftly into the front of the generous race. Abreast with the foremost of the competitors, he vies in speed and action with all that is noblest in horsemanship, and has been known to outstrip the fleetest coursers like the wind.

To put it differently, where the critic has imagination, his work generates—becomes creative. Not necessarily losing its value as comment and interpretation, it attains the higher value of invention, and mates its own comely offspring with the children of his author's genius. Or, to put it otherwise yet once again: if truth and fidelity are the religion of the critic, the incidental creations of his glowing mind are his *aberglaube*—his "extra-belief"; and it has been known for these products of critical enthusiasm to exceed in value the texts in which they germinated.

If all this is true, or can ever be true, of Criticism, it is rather irritating to find Mr. Ruskin, himself one of the

noblest exemplifications of Criticism thus splendidly aggrandised, groaning out in the evening of his day that Criticism is as impertinent in the world as in the drawing-room, and that while a bad critic "is probably the most mischievous person in the world," a good one is "the most helpless and unhappy." So far as this grief of Mr. Ruskin results from his craft being ill-appreciated, let us endeavour to remove its cause by throwing the weight of our influence, one and all, into the right scale. But surely, with Mr. Ruskin's own great fame before our minds—a fame only dimmed when his common-sense has fallen inefficient, and his power has been stricken as it were with a St. Vitus's dance of whim and eccentricity—we need not share his gloomy notions of the critic's work and rewards. A branch of literature which has yielded to us some of the finest work of Dryden and Addison, of Coleridge, De Quincey, Charles Lamb, William Hazlitt, Lord Macaulay, Theophile Gautier, Ste. Beuve, George Lewes, Walter Bagehot, Oliver Wendell Holmes, and Thomas Carlyle, is in no danger of losing credit among those who worship literary Immortals.

Of all the jibes by which critics have been outraged, one of the lightest has most lacerated their not very tender susceptibilities. The author of "Lothair" has put into new and epigrammatic form the sneer that critics are persons who have failed in Literature and Art. To this, if it need be seriously answered, there is an altogether effective triple reply. First, there are many critics who cannot have failed in creative authorship, since they never attempted it. Secondly, there are many critics who cannot be said to have failed in Literature and Art, for, without attempting creative authorship, they have produced in critical works some of the finest original creation that is to be found in printed books. Thirdly, if there are critics who have fruitlessly attempted literary creation, the fact says nothing against

their Criticism, which may be of a high order without the creative faculty—nay, it says nothing against their creative faculty, for many writers have the gift of creation in Criticism, though they exhibit it in no other form of literary production.

Original literature may be classed under three heads. There is (1) the literature which is ostensibly and distinctly creative. There is (2) the literature which is incidentally creative, but which, in form, in method, and in intention, is of the nature of comment and interpretation. And there is (3) merely observational literature, whether of appraisement, elucidation, or correction. Works of history and biography partake of the characteristics of all these classes. There is a popular delusion, in which many essentially creative artists share, that the second class—the incidentally creative—has no very real existence, and may, without any great injustice, be placed among works of mere literary scrutiny and comment. My contention is, that in this second great order of literary production are to be found some of the most original and some of the greatest products of the pen, and that that is the Place where the Power of Criticism is throned.

Unfortunately, the throne is somewhat unstable, and rather shabby. Its glory is not duly recognised. The pretenders to it are often presumptuous and often dilapidated. The succession has not been preserved. The constitution of the realm has not been reverenced. Even the usages of Criticism have been largely laid aside. I am among those who lament the decline of the Essay. I should like to see many writers attempting labours similar to those in which Mr. Matthew Arnold, Mr. Leslie Stephen, Mr. John Morley, and Mr. George Saintsbury excel. The monthly collections of signed articles which have to so large an extent taken the place of the Quarterly Reviews, have rendered a great service to the English world in developing individuality and moral courage; but, as a rule, they present few good examples of

style, which is an indispensable vehicle for effective criticism. The marked personal identification of the author with his work, as a sort of manifesto, detracts both from the charm and from the value of much that appears in these miscellanies. Many of the papers are rather slip-shod addresses to a large jury than literary compositions of note and worth; and, as the barrister is governed by his brief, so many of these *Contemporary* and *Nineteenth Century* writers are affected in the tone and tenor of their contributions by their personal pretensions and positions, and by the relations which exist or which they wish to exist between them and their audience. In so far as the eager controversy and animadversion thus carried on from month to month denotes and increases an appetite in the public for the discussion of worthy topics, it is to be highly esteemed. But, as it produces an exceedingly small amount and a rather poor quality of literature, it cannot be considered an adequate assertion of the Place and Power of Criticism.

What I am anxious to take the present opportunity of submitting to an audience especially pledged to the pursuit of intellectural studies is, that Criticism is produced by a special faculty, the products of which ought to be watched for and enjoyed with as full a belief in their utility and beauty as can be safely cherished in reference to original productions. There is no lack among us of admiration for the admirable in the domain of pure creation, but there is a grudging recognition or a scornful repudiation of the excellent and new which comes of labour in the observation of, and making observations upon, these admirable productions. "We are surprised," says Mr. Bagehot, "that writers should wish to comment on one another. It appears a tedious mode of stating opinions, and a needless confusion of personal facts with abstract arguments; and some,

especially authors who have been censured, say that the cause is laziness—that it is easier to write a review than a book, and that reviewers are, as Coleridge declared, a species of maggots, inferior to book-worms, living on the delicious brains of real genius. Indeed, it *would* be very nice, but our world is so imperfect! The idea is wholly false. Doubtless it is easier to write one review than one book; but not, which is the real case, many reviews than one book." And the comparison which thus holds of the labour of writing holds still more closely as to the worth of the work. A great book, a great painting, a great speech, a great despatch may surely be as fit a subject for literary overhauling as the great subject which may have been treated in either of these ways. And the value of such Criticism is all the greater if we consider that it will make appreciable by thousands of minds beauties that might only have been discerned by hundreds, while it will very likely offer to those same thousands at least some beauties of its own creation. My aim is to induce all who have not yet recognised the Place and Power of Criticism to become conscious of this defect in their judgments, and to impel them to correct it. And in pursuing this purpose I start with the firm belief that our intellectual nature, by its laws, amply repays all intellectual labour—repays it manifold, and in various and unexpected ways—and is not least likely to repay it magnificently when it is employed in reviewing the noblest, or, at any rate, the most suggestive, of previous intellectual efforts.

We need to understand that there is an express and special critical faculty compounded of perception, sympathy, taste and judgment; that there is a critical mood, a critical capability, a critical aptitude, a critical genius; that men of high literary power may have these in rich measure just as others may have the faculty of narration or of poetic composition; that powers of this type may exist in the absence of

the gifts which are more conspicuously creative; that they may, however, achieve great things in literary creation; and that whether they create or not, they are of great utility in securing for the products of other powers the discriminating consideration to which they are entitled.

The speciality of critical ability may easily be understood if we glance back among our own recollections or around among our own friends, and ask ourselves whether it is always to the most learned that we should go for the settlement of a point of significance in literature—whether the greatest painters we have known have been the best critics even of their own works—whether the finest actors are the best judges of acting. Six men are seated round a table. They are experts in an ancient language. They are in high discussion on the use of a phrase in an ancient text. They lavish infinite learning upon the dispute. Their ingenuity is endless in the use of analogies, in the tracing of etymologies, in the multiplication of readings. Their skill is worthy of special pleaders. Their forensic agility would do credit to the Old Bailey. But somehow the discussion does not approach a conclusion, and a listener, if he knows what Criticism ought to be, is astonished at so prodigal a waste of learning and at the pettiness of the argumentation all round the table. Now, suppose the six men bring in as umpire, shall we say, a Ste. Beuve. He is ignorant of the language of the text they are debating, but he is not slow to ascertain the merits of their quarrel. He masters speedily enough technical knowledge to guard him against mistakes. He looks at the passage this way and that, and by a shrewd question or two satisfies himself on aspects in which it may be of doubtful interpretation. As soon as by this aptitude of relevant enquiry the great critic has dissipated any films of doubt that may hang over the subject, his quick, sure insight comes into play, and then his delicacy, and force, and exact-

ness of expression go to work. In a moment or two all mystery and obscurity have vanished. The meaning of the difficult passage is elucidated. Its beauty is burnished and its facts are set in many a glancing light of sympathy which the learned logomachists would never have imagined. They indeed, or some of them, may repudiate the award—may deplore its lack of scholarship—may protest that the all-important bearings of a particle, or an accent, or a parallel passage on which each may severally have set his heart, have been wantonly overlooked. But any impartial possessor of an understanding mind will feel that the Ste. Beuve has brought light where there was worse than darkness, and that contours of beauty, textures of loveliness, side-lights and vistas of charm are visible where lately all was a desert Petræa of barren wrangling and stony strife.

I have seen a more popular illustration of the various characters of mind in the presence of things of beauty—an illustration which may serve not less effectively to remind us of the varied types of apprehension which it is the mission of Criticism, in its aspect as a gradual educator, to bring on to a level of adequate taste and appreciation. Four men on a wet day were lounging in the gallery of a country mansion. They had all been taken thither by their host to admire one of the loveliest statues that ever took shape in marble from a poet-sculptor's conception of nude female form. One fretted about listless, with his hands in his pockets, sometimes whistling and sometimes glancing at the skylight, as if a wish that the rain would give over was the only idea then worth entertaining. The second, an older man, fussed about the recumbent figure, double eye-glass on his nose, searching in vain for a flaw in the marble, and every now and then ejaculating, "Well, he lighted on a fine bit of stone anyhow!" A third seemed to be gazing in a stupor of admiration. There could be no doubt that he was feeling intensely that the statue was

beautiful. But his miud had no artistic play in it. His thoughts were vainly struggling with a sort of congestion. His untrained faculties were feebly trying to expatiate in a sort of sensuous vague—until he was addressed by the fourth personage of this little scene. What magic was there in the eye of this man, in his speech, in his very hands, which all seemed, as it were, in harmony and co-operation, to adapt themselves to the lovely undulations of the pure marble? Was it at his tender half-touch that the transparent substance seemed to quiver with the delicate elasticity of nature? Was it his breath or the statue's that seemed gently to expand the softly-moulded bosom and to dilate the exquisitely-chiselled nostrils? Was it at the bidding of his description that the rounded yet myriad-surfaced arm sustained so symmetrically the weight of the reclining figure? Or did his description only reveal what had been there ever since the sculptor thus faultlessly poised the fair form of his snow-white dream? Who should say whether it was the fancy this man had kindled or the reality he had more perfectly perceived, that made us understand the radiant delight, the ecstatic contemplation, which appeared to be reflected up into the statue's beaming face from the limpid mirror-pool, newly conjured into our imagination by a word or a sweep of the hand, and now seeming to be shining in its fair expanse beneath Eve's glowing gaze? No, it was not invention, for it lived there unquestionably, now we saw it, and would live as long as we could see or remember the statuary's masterpiece. Yet it was not till the critic's words, and glances, and gestures began, that to those of commoner clay the marble had expressed to the full these wonders of the chisel—wonders, perhaps, which even the wielder of that chisel might not have realised without critical help as the true and legitimate fruit of his own inspiration.

If this is a true and not uncommon experience—if, on the

one hand, average faculties of understanding and enjoyment need to be thus assisted, and, on the other hand, there are gifts abroad in the world which thus effectually assist them—surely it is a mistake to underrate the Place and Power of what in innumerable cases is essential for the full revelation of beauty, and what in other cases, besides revealing the beauty that is, creates new beauty which as yet neither eye has seen nor thought conceived.

Yet I find even so distinguished a critic as Professor Sidney Colvin minimising the prerogative and arbitrarily lowering the dignity of his own calling. He tells us that the critic must be on his guard against his own literary ambition—which is as if he were to warn the sculptor or the painter against the force and suggestion of his own inspiration. "An indifferent picture or statue is," he avers—but why, he says not—"a higher achievement than the Criticism which points out why it is indifferent." Here we have a gross instance of the want of efficient common-sense, which renders worthless so much of what passes for Criticism. Is it not clear that the comparative merit of the Criticism and the picture must depend on the positive merit? And can anyone, except to indulge a whim of æsthetic affectation, pretend that a picture which may be at the very zero of inferiority must be a higher achievement than a Criticism, which, in defining and gibbeting the badness of that picture, may give to the world, in word-painting, a conception of what the picture might have been, such as may either defy or inspire the pencils of a thousand greater artists than he whose failure piqued and spurred the critic's brilliant fancy. Would Shakspeare's description of the brook in the "Two Gentlemen of Verona," or of the samphire gatherer in "Lear," have been essentially inferior if it had occurred in prose in a critical disquisition legitimately suggested by

something in an artist's work? Are the observations of a Burke on passing public affairs deformed by the wealth of original suggestion which gives to the overflow of his criticism a value higher than attaches to any of the events or deliverances which come under his review? "Fine Art," says Mr. Colvin, "whether manual or literary, reports directly concerning life and nature,—Criticism only interprets and characterises the report, and makes it more intelligible and better known." But surely the reports of Art on Nature and Life are a part of Nature and Life, and therefore the Criticism that reports on these reports may, by Mr. Colvin's own rule, be of the nature of Fine Art. Mr. Colvin well knows that a great deal of criticism is fine art. He evades the case of Mr. Ruskin, by saying that it is impossible to lay down a law for genius; but surely it has been usual and salutary for genius to set the fashions of literary work and enterprise. The crabbedness of such censures as Mr. Colvin's is illustrated by his venturing to say, even of Mr. Ruskin, that his interpretations of works of art would have been more just and final if he had kept them more severely to the point. Justice, of course, is essential, but in Criticism sincerity is of more consequence. Sincere Criticism, though it may be unjust, seldom does any injury, and if Mr. Ruskin has ever failed to be just to works of art, he has made up for it by many suggestions which are works of art in themselves. As for finality, who cares for it in Criticism? Who wants a final judgment of a single line of Shakspeare, or of a single shade of Rembrandt, or of a single phrase of Beethoven? It is not hard-and-fast and final pronouncements that we ask of Criticism where there is true achievement, but the worthy observations of capable minds, stimulated to the utmost by what they contemplate, and capable of furnishing reasons for admiration or censure—food for the world's thought on the greatest themes. Yet Mr. Sidney Colvin, in his fanatical

veneration for the purely creative arts, which yet he defines as purely imitative, would limit the critic to mere technical discussion. "If any one has great and new things to say concerning life and nature, let him say them in the appropriate artistic or didactic form." Again, I ask, why this arbitrary restriction and dictation? Why should I be compelled to read comments on pictures and statues and buildings in one set of books, limited strictly to "the actual qualities of the work and the precise message which the artist has intended to convey," and in another set of books, divorced from the themes by which they are suggested, and consequently comparatively unreadable, the various observations and excursions in which a great critic must be tempted to indulge? Nine artists out of ten, whether in painting, writing, politics or otherwise, have rather vague ideas of the message they have to convey, and the work of such will be all the better for friendly interpretation. Their message has probably enlarged and wandered under their hands. It may be better delivered by the critic. Or it may extend still further, or range still wider, under the critic's conduct. In this case no reader sufficiently enlightened to read Criticism with the understanding will suppose the critic to be answerable for the artist or the artist for the critic, but the world, so far as the world attends to such matters, will have three works of art instead of one—first, the original work; secondly, a fit and remarkable literary duplicate or version of it; and, thirdly, the new and fresh suggestion of the critic, the merit of which must be judged independently, as the product of a mind distinctly original and creative, though employed, while in the act of creation, in appreciating and describing the more ostensibly original and creative work of another mind and hand.

Such a discussion as that into which Professor Colvin

has invited us must bring to our recollections what Wilhelm Meister did for Hamlet. It is only necessary to look into previous discussions of that great Shakspearian character to feel how poverty-stricken was Shakspearian Criticism before the time of Goethe. From the publication of Wilhelm Meister the popular conception of Hamlet began to develop, and all Shakspearian Criticism began to gain in spirituality and depth. Whether Goethe successfully interpreted Hamlet is of minor importance. Hamlet may be a hundred different men to a hundred different readers. But the Hamlet of Wilhelm Meister, by the magic of Criticism, raised all other conceptions of Hamlet. It taught all students of Shakspeare to expect something more than they had been expecting, and we of the next and next generations inherit these expectant traditions, instead of the narrow and almost dry channels of Shakspearian thought with which even the mind of a Johnson was content, because Criticism had not then opened the fountains which Goethe's rod smote from the rock. We, in our day, have come to see how Shakspeare embodied and anticipated the ideas of all the ages—how, for instance, Hamlet is the type of what is called, though not with strict propriety, over-cultivated humanity—how he anticipated the contemplative irresolution of the man who expends his natural force in high and curious meditation—how it was necessary for Hamlet, in order to resolve on anything, to descend from his own intellectual level; as, for instance, after the march of Fortinbras, when the young prince goads himself on to action by a number of arguments which it is not in his nature to respect, and concludes that from this time forth his thoughts shall be bloody or be nothing worth, because

> "Rightly to be great
> Is not to stir without great argument,
> But greatly to find quarrel in a straw,
> When honour's at the stake."

Over and over again in "Hamlet," and often in other plays of Shakspeare, we have, as here, subtlety within subtlety—reasoning suggested by incident or mood, quite out of the ordinary vein of the character temporarily affected by it. Upon such metaphysics of the drama, fraught as they are with infinite moral meaning, as well as with infinite profundity of art, only the highest Criticism can be effectively employed, and I mention this to suggest how grandly the province and efficacy of Criticism is illustrated by the vast addition to Shakspearian thought which was irrevocably commenced by the great German poet, in the estimate which so promptly and immortally riveted the attention of the world. Is it not significant, in reference to my present theme, that this great feat of Criticism was accomplished, not in a critical work, but in a work of fiction, and would probably have passed unnoticed by Europe if it had appeared as a Shakspearian Essay?

There is no defection, either from loyalty to Shakspeare or from loyalty to Goethe, in saying that the Hamlet of Wilhelm Meister was in some sort a creation. It was no less a creation for being a criticism, and no less a criticism for being a creation. There can be no doubt that, although this is the most remarkable case on record, many of Shakspeare's characters have, ever since they were produced, sustained vicissitude of estimation and comprehension from similar causes. There is an irregular gradation in these things, governed by blended or alternate processes of Criticism and creation. Take, for instance, "Othello." In its original form it was a simple Italian story, with but little character in any of the personages except Iago, while the catastrophe was extremely clumsy, devoid of tragical climax, and coarse in its details. It passed into the crucible of Shakspeare's genius, and obviously the fire to which it was there submitted was a fire of Criticism. If anyone wants to

comprehend what the Criticism of a noble and creative mind is like, let him read Cinthio's story of the Moorish captain, and then read Shakspeare's play. There is a fascination even in the smallest features of such a comparison. For a critic nothing can be more delightful than to notice in detail the masterly improvements of the great dramatist. Nay, such an expression seems odiously formal and utterly inadequate to describe the process of suggestive creation, which, while clearly accounted for in its origin by Cinthio's comparative crudities, seems in its essence absolutely independent, and in another world of thought. To say nothing of Shakspeare's new conception and grand elaboration of the characters, there is not a vulgarity in the Italian novelette which our great poet did not refine. There is not a bare place in the fabric that he did not enrich with some gem of appropriate incident, colour, or humour; while many a triviality of the original he informed with the choicest poetry. Cinthio, for instance, though he makes much of the handkerchief, does not represent it to have possessed, or to have been supposed to possess, magical virtues. With what matchless art does Shakspeare add this element of interest, so as at once to deepen the tragedy, to give a local tint to the atmosphere, and to decorate the text! "A handkerchief," says Cinthio, "that the Moor had given her, and which, as it was very delicately worked in the Moorish taste, was very highly valued by them both." "That handkerchief," says Shakspeare—

> "Did an Egyptian to my mother give;
> She was a charmer, and could almost read
> The thoughts of people. She told her, while she kept it,
> 'Twould make her amiable, and subdue my father
> Entirely to her love; but if she lost it,
> Or made a gift of it, my father's eye
> Should hold her loathed, and his spirit should hunt
> After new fancies. . . . .

. . . There's magic in the web of it:
A sibyl, that had number'd in the world
The sun to course two hundred compasses,
In her prophetic fury sew'd the work;
The worms were hallow'd that did breed the silk;
And it was dy'd in mummy, which the skilful
Conserv'd of maidens' hearts."

It is impossible to read even so slight a matter as a description of a handkerchief in "Othello" without perceiving how, from its rudiments, the character as well as the story grew under Shakspeare's mind into the rich oriental wealth by which we should be surfeited but for the chastening gloom of the story. Following the history of the play from its origin in Shakspeare's criticism and imagination, we should find that, though its substance remained unaltered, its effective entity underwent vicissitudes. Each notable actor is a Shakspearian critic, good or bad—often the worst critic when the best actor. If his conception is noble, whether accurately sound or not, his art assists the critic proper. If it is mean, or dwarfs the part or makes it common, the work of the critic proper may be for that generation put back; for the Place and Power of Criticism in a less than half educated community is but ill assured. Sometimes it may take two or more of the greatest actors to make up—*minus* the faults of each—an embodiment that can be considered even reasonably adequate of a great creation of a great poet; and such is the dependence of the public on popular presentations, that each one which seizes upon the general mind is virtually a new creation, either on a lower or higher level than that which previously obtained. This deserves mention as illustrating not only the Power of Criticism, even when unconsciously exercised in the form of artistic assumption, but the great blank in the general mind which exists in consequence of the critical faculty being wholly uncultivated and

unexercised. I have in my mind three great performers of the character of Othello. The first realised the imaginative splendour of the Moor's personal and intellectual individuality so grandly, that any derogation from the height of his conception would have seemed to the public, while under his influence, treason against the genius of Shakspeare. But ere he was quite forgotten another Othello burst upon the town. His personal dignity was not less, but the majestic Moor lost, in his impersonation, the mental loftiness that had been identified with him. The noble drapery and embroidery of Shakspeare's language went almost for nothing. The pomp had lost its poetry. The rapt and racked mystery of a grave barbaric hero was exchanged for barrack *brusquerie* and the savagery of the shambles. Yet another Othello appeared, and with him a new and wholly unprecedented light and life beamed upon the dramatist's classic page—the light and life of a love and a domestic enthusiasm, which neither literary nor histrionic commentator had ever before found in Shakspeare, though it clearly enough was lying there for whoever might have the insight to discern it. The impersonation, however, was generally felt to be wanting in the essential grander qualities, and did not seize the attention of the public. There was something in each of these great renderings, and there has doubtless been something in every great rendering, that could help towards a true and—what is still more important, perhaps—towards a great and inspiring realisation in the popular mind of Shakspeare's creation; but it is deeply to be regretted that, through Criticism proper having lost or never having gained its just Place and Power, the right judgment of matters of such undying interest, by even the proportion of the community supposed to be educated, should depend upon casual and unsystematic stage instruction. If you think this cause of grief slight or whimsical, I will not shock anyone's susceptibilities by saying

how many and what great things I deem less important than the understanding enjoyment by a nation of the works and doings of its greatest men; but I will venture to point out to you that average people of the English race, while they may have low or lofty views of Othello, according to the manner in which the character has recently been acted, have literally no views at all about Milton or Wordsworth, Dryden or Tennyson, because these poets are not in the way of being interpreted by visible action and the living voice. Plato, says the great English classic who has familiarised this generation of readers with his speculations—Plato "compares the poets and their interpreters to a chain of magnetic rings suspended from one another and from a magnet. The magnet is the muse, and the large ring which comes next in order is the poet himself. Then follow the rhapsodes and actors, who are rings of inferior power, and the last ring of all is the spectator." What was worthy of being symbolised by Plato in the noblest age of Greece cannot be undeserving of consideration by the *litterateurs* and philosophers of to-day. Nor can it be an unworthy aim to do anything which may tend in any degree, however humble, to multiply in England the number, at present so small, of little rings, thrilling with the magnetism of communicated genius, and pendant from the greater rings of critical sympathy and interpretation; these again hanging from the still greater rings of creative achievement, which, in their turn, are suspended from and magnetised by the great universal circling source of mind and life: of all being that is noble; of all action that is beneficent; of all thought that increases the common stock of happiness.

Our appreciation of the great office and function of Criticism will be raised and justified if we consider that the promise is to its exercise rather than dependent on the

absolute correctness of its results. If we could only think that the people of England were likely soon to indulge in Criticism as an enjoyment, to practise it as part of their education, to cherish the true spirit of it, and to consider the conclusions at which they should individually and experimentally arrive as the most precious acquisitions of their lives, we might be comparatively indifferent as to the precise accuracy of their opinions or beliefs, even on important subjects. The spirit of culture may always be trusted, at least, to keep men out of mischief. The pursuits of culture expel everything that is ignoble, except that pitiable indisposition for participating in public affairs, of which, on both sides of the Atlantic, there has been reason to complain. This, however, after all, is only a bastard Ishmael growth of higher education. It will eventually be turned out into the wilderness to die, along with its slave-mother, Social Affectation, and will find no good angel in the outer desert to slake its thirst for life. A higher education still will train out of the cultured classes all such bad and selfish, such miserably short-sighted, ways of thought, and in the habits of Criticism and the common-sense contemplation of great works and acts will be found invaluable springs of salutary impulse. A stream may be precious and refreshing, though it makes very deviously and desultorily for the sea; and the mood and intellectual usages of appreciative Criticism, if they could only be more widely spread, would be of incalculable advantage, whatever accretions of error might incidentally attend them. In fact, to put it broadly, the value of truth in Criticism, though in one sense great, may in other senses be overrated.

The imaginative action of Criticism is never more brilliantly or wholesomely exhibited than in the elaboration of judgments or views of great works, and though these must be considered in reference to their accuracy, they must not be considered solely with that reference; least of all, with sole

reference to the author's intention. This is not an all-important, and may be a minor consideration. Any actual theory of an acknowledged great work in which there is mystery, or room for different interpretations, if it be of sufficient interest to occupy the mind of a competent critic, and to engage the consideration of his readers, must be an important hypothesis, if nothing else. If it is sound as an interpretation, and has not been hitherto held, though it cannot be said to create anything, it certainly adds to the world's wealth, or, at least, to its intellectual circulating medium. Moreover, there is no need that this welcome discovery of the truth should extinguish, or bring to shame and contempt, other views which have previously prevailed, and which, though now rightfully despoiled of their presumed authority as accurate, may be well worth bearing in memory for their intrinsic beauty. If the theory advanced is new, but not true, regarded as an interpretation, the common instinct is to prove the critic wrong as an interpreter, and then to drop him and his work, however beautiful and suggestive it may be, into oblivion, just as you crumple up a mistaken memorandum and throw it away. But, as I have just hinted, a conception untenable as a criticism may be of value for its own sake as a creation. A sound judgment will reject it if it is too fantastic or repulsive, but if it be worthy of contemplation and remembrance, it cannot be less so because only suggested by, and not a strictly exact interpretation of, the great work which its author has endeavoured to criticise. There have been critics who when they have conceived a supposed meaning of a great work in this manner, though there may have been no just foundation for their supposition, have had the power of expressing it with all the fulness and force of creative composition. In such cases the work of critics thus produced, though it would not have had being but for the previous

existence of the works which are commented upon, takes high imaginative rank (or ought to), and has to be (or should be) placed alongside of great creations.

Our arbitrary æsthetic gentlemen step in and say that if men have it in them to create, they should produce avowedly creative literature. But it is of no use to make these exactions. There are critics who while possessed of the power of presenting views of great works which, being of value and yet not being true interpretations, are therefore fine creations, fall short of the poetical faculty, or the instinct for form, or the literary enterprise or address to place them as creations independently before the world. Why should such conceptions be ignored or discarded? So far from being abortive, they may be full of essential life, and in their germinating power may be found the origin of many future creations which, coming from minds of the approved poetic order, may bewitch and entrance the world. The power of giving true estimates of the meanings of other men, or of their works, is essential to exact Criticism; but Criticism may be fruitful without being exact; and while the critic who is not exact in apprehension must fail in his proper function, his Criticism, if only fruitful, must confer great intellectual blessings on the world.

Indeed, there are possibilities conceivable here which have never been realised in the history of Literature, because only genius such as Goethe's has won for itself the privilege of contributing, through the channel of Criticism, ideas which, according to usage, should come through the channel of Creation. If we only think how daring an attempt it is to create, and to create in a distinctly and avowedly creative fashion, we shall see that the humbler office of the critic should be all the more highly esteemed if incidentally his rod of divination should bud and blossom. Perhaps, hereafter, there may be co-operation between the peculiar imperfect

creative faculty which, as it were, finds jewels when seeking gold, or precious treasures lying by in the ore when scrutinising the work of the goldsmith, and that other, if not higher, faculty, which may be necessary to carry out the conceptions which this critical faculty originates. The spontaneous imagination of the author may be wanting in the critic; but the imagination of the critic at second-hand may be finer than many a creator's inventions. And, indeed, just as many a productive intelligence would be sterile but for being employed on the conception of more creative minds, so many which pass for and are creative are equally dependent on outer suggestion for the groundwork of their imaginative work, and are chiefly distinguished, as we see in the case of Browning, by their treatment of such subjects as are suggested to them. There may hereafter be great works produced, by the interlacing of such diverse faculties—by a bold and liberal poetical treatment of conceptions thrown out by critics whose power and imagination are limited to the curious faculty of attributing to earlier writers great meanings and intentions which never entered into their heads.

If upon this view of the two orders of mind we are required to discriminate between them, and to assign to creative Criticism as distinguished from creative originality its peculiar mark, it will be evident that critical writing is the proper business of those who can do much upon suggestion and little upon subjective impulse. It will save us from many mis-judgments if we recognise the existence of these two types of mind, and value on its own merits whatever each may yield us.

Were this better understood we should not have men like Professor Shairp saying that they are weary of Criticism; that they have heard the best she has to say; that she should now stand aside for a season and give spontaneity its turn.

Surely the indefeasible peculiarity of spontaneity is that it is spontaneous. To call upon spontaneity to come to the front is the idlest folly. But while there are great works extant and great deeds on record, or being done, bright intellects all over the world can be set to work criticising. Even dull ones will be the less dull for trying to criticise, and those which succeed will yield each after its kind and degree fruits not unworthy of the spontaneity on which Professor Shairp vainly calls.

"It was not," he says, "by vast stores of book-knowledge, not by great critical efforts, that the long line of England's poets has been maintained. To them the actual life of men, the face of nature, their own hearts, these were their first and best teachers. To know these intimately was their discipline, supplied their material. Books and book-learning were to them a quite subordinate affair. The demand for a great critical effort as the prerequisite of creation seems to put that first which is not first, and to disallow that instinctive knowledge of man and of nature which is the poet's breath of life. This view of things probably originates in the conception of Goethe, as the typical poet of the modern era. Whatever worth it may have in itself, one thing is certain, that, had it been believed by former generations, English poetry would have been very different from what it is." Probably it would. So would English art, English oratory, and English public life. And all other poesy, art, oratory, and affairs which do not proceed absolutely by rule and science. I am not concerned solely with keeping up the race of poets, and I do not propose to examine very closely the bugbear of which Professor Shairp is afraid. But it seems clear to me that he is intent on a bad investment if he wishes to keep the youth of England from Criticism and culture in the hope that some few of them may gaze into the face of nature and their own hearts until the afflatus of poetry takes possession of them.

To study great things in the spirit of great Criticism must be good for all. To many it is as hopeless an effort to be good critics as to be poets; but the latter effort must end in vacancy and flaccidity, while the former must at least fill and brace the mind. Be sure that if an intellect has in it the gift of spontaneous creation you are not likely to extinguish it by culture, while there are thousands of minds which will never either create or in a large sense understand if they are discouraged from studying and judging noble achievements. Why foster this unnecessary and impolitic antagonism? Each extreme is extravagant. There are two orders of intellectual minds which will not as a rule pass into each other, or even very freely intermingle with each other, but they are not devoid of each other's fine and fertile qualities. Both are invaluable. The smaller class, of rarer minds—because from them may be anticipated whatever the future may yield of high intellectual adventure. The larger class—because in it there is an infinite possibility of general culture, ensuring the highest attainable amount of wisdom and of good taste, of devotion to what is generous and heroic, of fidelity to what is truest and best. There can be no good reason for sowing enmity or jealousy between the creators and the critics, especially as the classification, though distinct in fact, may not be clear in show, and had better be left for nature and experience to elaborate and make manifest.

Some very fine examples might be named in which the critical and the performing faculties are blended in a manner quite phenomenal, and producing mixed results. Every one will know to whom I refer when I speak of a great statesman distinguished from his fellows by this peculiar structure and play of mind. In him Criticism and speech are simultaneous and co-operative. Criticism and business thought go together.

Criticism and planning are inseparable in the working web of his mind. Although he is one of the greatest orators of this or any other time, it cannot be said that this constant secretion of Criticism improves his eloquence. It rather overlays and entangles his speeches with self-questioning and answering. While making them marvels of illuminated intricacy, it brings them into disadvantageous contrast with those of his only considerable rival as an orator, whose faultless instinct gives to clear thought the forms of classic simplicity, and who, in the easy and unembarrassed directness of a mind not drawn in too many directions, goes straight to the mark with the stately sweep of a surely-launched arrow. The minutely reticulated and variegated oratory of the great statesman who is almost as much composed of Criticism as of device, is endlessly interesting, and will be infinitely instructive in all time. Its excess of critical digression must deprive it of the very highest place in history. But even excess of the critical faculty has its compensations. Inartistic in its effect upon his speeches, his exhaustless and remorseless criticism has had an excellent effect in administration. His statements of great measures have been wrought with a care that made them invulnerable even in their weakest places, and tolerable and fairly satisfying even in points where they were not justified in principle. Some may say it would be better that an ill thing should not be done, but those who study the philosophy of government will understand that the well-doing of ill-things that cannot be avoided has a great deal to do with the happiness and convenience of the world. We have here an illustration of the value—while admitting the drawbacks—of the critical faculty in affairs.

Let me suggest, if I dare, that Science suffers somewhat from its literature not taking sufficiently the form of Criticism. In Science, every man is an expert, and, therefore, a

combatant. There is too little correlation between sciences, and between scientific minds, and the hypotheses which are espoused appear to outsiders to be maintained with too much dogmatic iteration and too little discussion. Partisanship is not unknown, and the methods of demonstration and the degree of their validity seem to literary observers to be susceptible of more critical settlement than it is usual for scientific men to give them. Political Economy has only been saved from absurdities, to which its professors for the most part seem reconciled, by the intrusions of a Criticism based on common sense and common observation; while Physical Science appears to have been too much occupied of late in dogmatising beyond its sphere, and of subsequently swallowing its own indigestible dogmatisms in a manner which has frequently laid it open to the rebukes of Criticism.

What I am more concerned to offer in this place, however, is a warning to those humble students of science who can scarcely hope either to make discoveries or to trumpet them to the world with florid variations. As a follower of general Criticism rather than of particular study, I am aware that I do not speak in the character which most naturally commends itself to their estimation. But I tender the respectful suggestion that the constant occupation of the mind in accumulating facts must tend to reduce its general power and capability. It would ill become me here to express myself censoriously, or even coldly, in reference to any scientific pursuit. But the objects of our Society, as well as the natural and well substantiated laws of intellectual life, justify me in this hinted caution. I will not insist on the comparative effect of exclusive scientific and exclusive literary studies on the individual mind. We have among us, in one of my most honoured predecessors, a venerable and venerated example of how the closest and most scientific familiarity with Natural History may be elegantly and philosophically

combined with a general interest in all human thought and a catholic enjoyment of all literature. Culture such as this must even enhance the subjective value of scientific knowledge; but its great advantage is, that the habit and the materials of Criticism which it establishes and supplies, balance the capacities of the intellect, and keep the judgment in that vigorous exercise for which the docile acquisition of scientific information does not appear to afford sufficient scope or incentive.

If we turn from the subjective influence of Criticism to the pleasures and benefits which it yields in literary enjoyment and study, a wide and exhaustless theme opens before us. To Criticism we must look for delicacy, and as culture advances delicacy becomes the principal source of disquisition and discussion among the cultured. Criticism sublimates the pleasures of reading people by giving them a medium of thought and apprehension; makes them free of the great literary guild, though they may not print or even write, and provides them with materials for thought arrayed and ordered in the manner most contributory to profit. We have seen in the illustration of Othello how the greatest masterpieces are capable, under an interpreting treatment which is virtually critical, of making varied impressions on the popular intelligence. It would be equally easy to show how under a scrutiny which is actually critical a masterpiece such as the "Paradise Lost" takes various noteworthy and beautiful aspects from the labours of an Addison, a Macaulay, a Bagehot, a Dallas, a Masson, and many other critics. In the natural course of things an increasing degree of attention to such works must settle in all capable minds their chief and most salient features, which when once truly perceived must be in the main the subject of a mute admiration. But when these grand displays have come to be thus taken for

granted, Criticism finds scope and room for thought in the minor touches, and in the examination, exacting yet candid, of minor productions, the happiest fate of which is to deserve in some degree the notice, and to please in some degree the taste, of those who have formed a critical judgment among the finest models.

Thus the growth of critical habits in the mind not only to a large extent constitutes culture, but gives meaning and dignity to the most casual literary occupations, and those habits themselves, and the mental perspicuity and fineness of touch which are necessary for their exercise, are kept up by a natural assimilation of whatever can sustain a critical faculty. While fully conscious of the necessity of thorough study, and of the remunerativeness, even to the amateur critic, of original literary research, I am most anxious to point out—for after all ours is a busy community—in what various and accidental ways the individual power of Criticism may be fed. Open at random a *Saturday Review*. A writer is picking out the choice morsels of Elizabeth Barrett Browning's Letters—a book one may be little likely to have time to read. The reviewer has marked some capital touches. His author has spoken of "the noble, clear *metallic* note in Macaulay's soul," and of "the *learned sweetness* of Tennyson's numbers." The reader will not forget either of these expressions. Perhaps, too, it is possible that he will some day enjoy an odd sentence of Macaulay, or a faultless line or two of the Laureate, the better for having read them. Here at hand lies another weekly journal, with a notice of Tennyson's early poem lately laid before the world. Let us see what assistance may be had from it in judging of the work, or what provocatives for discussion on it. My *Spectator* tells me it has more beauties than beauty, and that it is a characteristic of Mr. Tennyson's earliest works to be richer in the touches and dyes of true poetic feeling than in the form and grasp of true imaginative

power. Even in the later development of his genius, says the critic, he has never dealt so successfully with pure story and narrative as with great ideas and great characters. When he is working upon these his detail falls into its true place. You are not fretted with lingering touches on a languid theme. But in a simple story he overpowers you with heavy fragrance and tropical detail. "His genius needs pricking with a keen intellectual point. Leave him to his fancy, and you find it blossoming into all sorts of languid elegance and ornate tracery." And so on, the merits of the Idylls and Ulysses and Tithonus being discriminated from those of Aylmer's Field, Enoch Arden, Oriana, and Mariana. Now, it is not a question whether a reader of the *Spectator* agrees with all this. It is a question whether he will not be the better for having such things suggested to him in such a spirit. And the answer to this question must be in the affirmative, if he has leisure and taste for literary thought.

From amid the strew of an editor's much-oppressed table there peeps a corner of the orange-covered *Cornhill*. Many people are very scornful about magazine "padding," but it is a rich lucky-bag for the curious and critical. Let us dip. Our *Cornhill* essayist is concerned, on the page we open at, to distinguish between natural and artificial poets, and seems, at the glance we can now bestow upon his labours, to be somewhat embarrassed by Gray, who will persist in lying across the border line. After a try or two the *Cornhill* writer sets down that Blair and Young and Hervey have fallen into disrepute for want of "*the inquisitive felicity of language* which has preserved the Elegy." A rare phrase that—inquisitive felicity of language! Why, it makes a distinction not merely between styles, but between characters, between mediocrity and distinction, in almost every department of life! Inquisitive felicity of language! It has made Lord Beaconsfield a Premier! Ere the low-toned bustle of an age too busy for

Criticism degraded the commercial vocabulary, "inquisitive felicity of language" raised copying clerks to headships of corresponding departments and great firms, and even now, when America furnishes the dialect of trade, it is a perverted inquisitive felicity of language that keeps up the supply of Transatlantic slang. Before the oratory of the bar had degenerated into the hail-fellow-well-met colloquialism of commercial-travellers talking to their customers, inquisitive felicity of language used to make Solicitor-Generals and Lord Chancellors, and even in our own time there have been instances of forensic and judicial success so founded and attained. A main duty of Criticism, as a common possession and capacity, is to insist upon unity, precision, good choice, and the utmost possible pregnancy of speech; and there is no sphere in which this "inquisitive felicity of language" may not tell. You may well understand such a phrase, dropt by chance, sinking into the Nile mud of a confused but not incapable mind to bear much fruit after many days. One of the ablest writers I ever knew sank into comparative uselessness and pointlessness, not because he had lost the power of felicity or the sense of it, but because he had lazily ceased to be inquisitive after it. His junior would say to him, "That is not the word you wish to use," and he would reply, "No, but I could not think of the one I wanted." When it comes to this it is all over with a writer, and till a reader is similarly inquisitive for felicities of expression, he has not begun to know the highest joys of literary taste. In the one case Criticism has died out, and so lifeless is the still working mechanism, that we may almost take Criticism to have been the writer's soul—the pineal gland of his intellectual frame. In the other case the critical faculty has not yet been born; and the life of a reader who has no Criticism is like the life of a kitten before its eyes are open, or of a chicken in the shell.

Enough of the *Cornhill,* though its essayist has con-

densed into a word or two the best part of our theme. Close by, on the cover of another monthly periodical, shines the great name of Ernest Renan. Has he, perchance, a message for us? His subject is a dry one. We are not Talmudists. We are inclined to pass on. But stay; here is a stroke. M. Renan is annoyed by the moral obliquity of a certain Rabbi; and he accounts for it in a manner which goes straight to the heart of a critic, and should not fail to find an echo in every honest judge of Scriptural controversy. "Perhaps," says he, "the absurdity of Aquiba's exegesis deprived him of all practical rectitude. *One can never with impunity trifle with good sense, or strain the springs of the mind at the risk of breaking them.*" As we read the scornful, biting words, a whole region of religious controversy, and, what is worse, a whole region of supposed religious life, appears to come up for condemnation, and we listen to a judgment that we shall never forget.

Here lie two volumes of collected articles. The friends of Walter Bagehot have thought it worth while to give his ephemeral writings permanent form. We chance upon a reference to Goethe. In an epigram well worth remembering, the witty reviewer speaks of Goethe having had "*the cool shrewdness to wait for inspiration.*" The literary character of the great German was never sketched with more *finesse.* Turn the pages, and Mr. Bagehot is talking of the Whigs. Now, everyone thinks he knows what a Whig is; but how many of us could on the spur of the moment describe one? Perhaps one might be tempted to say that a Whig is a sort of Liberal and a sort of Conservative. Mr. Bagehot hits off in a memorable sentence or two, such as out of critical literature you will not find, the essential characteristics of the party. True, says he, they have a conservatism, "but it instinctively clings to certain practical rules, tried by steady adherence to appropriate formulæ,

verified by the regular application and steady success of many ages. Political philosophers speak of it as a great step," adds Mr. Bagehot, "when the idea of an attachment to an organised code and system of rules and laws takes the place of the exclusive oriental attachment to the person of a single monarch. This step is natural, is instinctive, to the Whig mind; that cool and passive intelligence is little likely to yield to ardent emotions of personal loyalty, but its chosen ideal is a body or collection of wise rules fitly applicable to great affairs, pleasing a placid sense by an evident propriety, gratifying the capacity for business by a constant and clear applicability. The Whigs are constitutional by instinct, as the Cavaliers were monarchical by devotion." Let us add a literary example. Our critic is comparing Scott and Shakspeare as portrayers of natural scenery. "There is beauty," he says, "in the north as well as in the south. Only it is to be remembered that the beauty of the Trossachs is but the result of a few elements—say brick and brushwood, rough hills and narrow dells, much heather and many stones—while the beauty of England is one thing in one district and another in another; is here the combination of one set of qualities, and there the harmony of opposite ones, and is everywhere made up of many details and delicate requirements; all which require an exquisite delicacy of perceptive organisation, a seeing eye, a minutely hearing ear. Scott's is the strong admiration of a rough mind; Shakespeare's the nice minuteness of a susceptible one." Here, again, it is no part of our present business to express agreement or disagreement. The common feature of my illustrations is that they address themselves to that instinct of sympathetic and discriminating observation which is the seat and the instrument of so much cultivated enjoyment.

Very often the distinctions drawn by Criticism are of great value in settling the taste, or, at least, relieving the

vague uncertainty of those who are perplexed by various competing phenomena of art and literature and life; and it may be argued with plausibility that for the fulfilment of this office nothing is better adapted than an intellectually conducted daily press. The brevity with which its judgments have to be pronounced render them very effective with dubious and timid minds, while the caution which the journalist combines with his decision and facility goes far to secure the soundness, or at least the reasonableness, of his judgments. The daily newspaper lying nearest me as I wrote this passage had found an opportunity to challenge, in reference to a new issue of Mr. Bright's speeches, the declaration of Milton, that "true eloquence was none but the serious and hearty love of truth." Another had addressed itself to a much-vexed contemporary question, "Art for art's sake," and I have not seen it anywhere else dealt with so pithily and sensibly. Even when no decision can be arrived at, and no judgment is attempted to be laid down, the mere mirror-journalism of the day affords to those who know the pleasures of critical speculation constant subjects of interest. There was an instance the other day, when, in a letter to an English friend, published in all the newspapers, the leading actor of the *Comédie Francaise* discussed the English and the French stage. When a likely critic undertakes a curious criticism, all who are interested in ingenious inquiries should listen intently. The great French actor found much to say in compliment, and some things in qualification, but the most notable thing he said lay outside his own immediate art, and raised a question of musical and dramatic elocution which cannot but be entertained with interest wherever public speaking or recitation engages the attention. The French actors had been accused of singing—that is, of declaiming with a certain rhythm and intonation. Their *doyen*, in replying to the charge,

suggested that English actors sang also more than they suspected, and that though English art, being less directly derived from the antique, and its force lying more in the genial force of the idea, required the use of measured rhythm less than the French, our actors were right in singing, "if the author wished it." There is something that Criticism may canvass with interest in these suggestions. But the unexpected and striking point of the great actor's observations was to be found in a sudden reference to the oratory of one of our greatest speakers. "A fine opportunity," he said, "enabled me to hear close by the pure, eloquent and harmonious voice of the illustrious Mr. Gladstone. What power! What charm! *And what would your actors lose by modulating thus?*" One feels in cases like this that Criticism has affixed a stamp of cosmopolitan authority to a subject of national pride, while by the comparison of ideas and instances questions of unfailing interest among nations of high intellectual civilisation have been illustrated in such a manner as to bring them under profitable reconsideration.

What may be truly said of the condensed and handy judgments of the periodical and daily press, and of the incidental contributions of material for thought and disquisition found constantly among the flotsam and jetsam of the age, is of course still truer of those who bring to Criticism special gifts and make it a special business. If we are able to assert with confidence the utility of all the slight and casual agencies which carry on informally and accidentally the work of Criticism, we are entitled to claim for those who are more distinctly connected with the interpreting and judicial branch of literature a higher Place in the literary hierarchy than is generally accorded to them. If it is a good thing to enjoy what is worthy—if it is a great thing to be right in judgment—if an enlightened man is bound to have at least a general knowledge of what is best and finest in the thought

of the world—if the effectual power of thought depends upon expression, and if expression depends on style, and if style is liable to degradation through neglect and the toleration of low standards, or the imitation of deformity: then surely a fine critic is of great men to be valued most of all, except the few loftiest creative originators whose productions shine conspicuous upon the grandest peaks of human achievement. This being so, I hold that sufficient honour has never been done to the men who have trimmed and held up the lamp of Criticism among us. Such men as Matthew Arnold, George Henry Lewes, Oliver Wendell Holmes, John Morley, Lecky, and Nassau Senior, who have used the key of learning and insight not to lock up but to open and distribute the treasures of knowledge—deserve not merely that we should recognise their superiority to all common errors, and their luminous leadership in safe paths of excellence, but that we should pay them the still better homage of using their works and their spirit more largely in the improvement of education and the pursuit of study.

Most remarkable is the value of these real critics as guides—the absence of danger in following them. There is no guile on their lips, nor any low enthusiasm in their hearts. There is nothing arbitrary in their authority, for they rule by reason; but their suasion has all the purity of innocent sympathy, all the sanction of established justice, all the force of a legitimate and undisputed reign. If they are not infallible, their errors are few, and the spirit in which those errors are committed redeems them. I know of no form or sort of literature which is so generally and truly free from moral perversion or intellectual obliquity, or from the indifference and flippancy which are the blights of social life. And their secret is easily communicable. The traditions of sound Criticism are not hard to learn. The judgment which so easily becomes weak by disuse, or warped by prejudice, is

as easily strengthened by being freely and sincerely exercised. The gift of expression becomes exquisitely sensitive and elastic without losing strength or trenchancy, as a Damascus blade can be bent from point to hilt and yet never fails or turns its edge at a lunge or a stroke. The disciples of a great critic are usually the disciples of several. They are at liberty by the terms of their discipleship to be the disciples of all. As for their own immediate master, they follow him confidently, but with discreet intelligence. It is alien from the spirit of his authority that they should adhere to him blindly or without full perception. They learn from him an acuteness which enables them to see whither he is going, and they let him go on alone when they prefer their own judgment. Meanwhile he and they, in their respective tracks, bring to bear on literature and conduct a firm though charitable censorship, which contrasts on the one hand with the maimed torpidity of the mere learner and storer of facts, and on the other with the callous light-heartedness of those who are indifferent to all but the grossest forms of literary or moral error.

Believing this to be no fancy picture, although unhappily it represents a minority even of the most cultivated intellects, I cannot but plead, though I may plead in vain, for greater and more detailed cultivation of the judgment in ordinary education. The popular cry against cramming is not a very respectable one. It comes in the main from parents whose children are not clever. They always assert that children who are not clever as a rule get on better in life than those who carry off all the school prizes. If so, there is the less reason to console them in youth, by withholding from the clever boys the short-lived gratification of juvenile success. By all means let competition go on. It is the fairest and indeed the only fair way of testing the abilities and acquirements of young people; and human nature must be

constituted differently from what is generally supposed if the habits and powers developed by severe emulation early in life do not produce corresponding results when school education is left behind. But while competitive examinations should be preserved, it may surely be possible to direct them more than they are directed to the testing of the *judgments* of those who are examined. For this purpose it would be quite easy to make Criticism one of the divisions of the general department which is known as English, and the adoption of such a subject would do much to obviate objections which are now taken to examinations in mere facts and dates. It will be freely objected that children have no judgments to test. But they are not likely to have judgments unless the faculty of judgment is brought into exercise. It would not be a difficult task for any examiner deserving the name of a critic, and realising what such an examination should be, to prepare papers for almost any age or standard which should test at least the existence of a capacity for judging, and the degrees of skill in recording and justifying the judgments arrived at. Another objection likely to be taken is, that it would not be right for marks to be assigned for the supposed correctness of answers on questions of opinion or taste. This might probably be left to the examiners; but one of the advantages of an examination in Criticism would be, that the ability, and enterprise, and aptitude shown in the papers—unmistakable marks of cultivated and available power—could be judged of without any acceptance of the opinions expressed.

There is something very lamentable in the manner in which, except in mathematics, and to a certain extent in philosophy, in the final examinations of one university, all that requires play of intellect is left untested. An examination paper in Shakspeare is often a most disappointing document. The boys in our schools might answer many such papers completely without acquiring any real mastery

or perception of the author, while their memories would be overladen in preparation with a mass of technical and archaic knowledge, not likely to improve their tastes or enlarge their ideas. Again, we live in a whirl of clamour on the subject of what is called religious education, and for those who are curious on the subject there are ample opportunities of testing what is practically meant by this phrase. In this town, indeed—where Education during the Forster *régime* has been under the auspices of two successive chairmen who have behaved in a spirit which may be called statesmanlike—the School Board has subsidised the pen of a reverend friend of mine (Mr. Pulliblank) to prepare a well-written synopsis of Christian doctrine which, while inoffensive to the parents of the majority of those who are expected to be instructed from it, is really successful to a considerable extent from the spiritual and moral point of view. But in most schools and many families of this country the so-called religious instruction is of the most barren type, consisting largely of the impartment of a number of petty Old Testament details which not even the extremest notions of the importance of Jewish history can invest with either educational or moral importance. I need hardly remind you that Mr. Matthew Arnold, in his monograph on Isaiah, has shown how a great critic would teach the Bible; and there are men more orthodox than Mr. Arnold—men such as Dr. Farrar—who might revolutionise the whole system of primary religious instruction to its great advantage, both as a spiritual influence and as a critical gymnastic.

Let me give you one instance which occurs to me of the manner in which instruction and examination in Scripture subjects, and, by parity, in other subjects, might be improved by the introduction of the critical element. The Epistle of St. Paul to Philemon is one of the most interesting and least understood of the compositions which make up the

Bible. It is, of course, impossible to dilate particularly at this moment upon its beauties; but those who are acquainted with, or who will observe them, will see that a most interesting Scripture lesson or examination paper might be made upon these points: the tact of the letter; its gentlemanliness; its bearing on the slavery question; its diplomatic reticence; its wisdom; its view of Christian brotherhood; its claim to inspiration in connexion with these qualities; and its introduction into morals of a principle unknown in the classical pagan world. This is, of course, a subject for a high class: but it contrasts favourably with the Scripture instruction which even high classes usually receive. It would give any young student quite a liberal Christian education if he intelligently supported the points of it from the text. And similar subjects might easily be similarly treated for junior pupils, to their great benefit and enlightenment, and their happy deliverance from a burdensome mass of technical and trivial instruction.

While touching very briefly on Holy Writ, I cannot refrain from reiterating a belief, which elsewhere found expression in some remarks on our late President's ingenious and powerful first address, that the most crying religious and theological want of the day is the gradual but unreserved popularisation of the results of the literary Criticism to which the various compositions which make up the Bible have of late years been subjected. It may appear a great deal to demand, but I humbly think the Place and Power of this Criticism should be exhibited in the pulpit, where, except by a few preachers, it is absolutely ignored. Are our clergy ignorant of modern Biblical Criticism? If so, what are we to say of their preparation for their holy office? If they are acquainted with it, and are convinced of its truth, what can be said of their honesty? If they believe it to be erroneous and controvertible, what must we think of their courage?

Here they should manifest transparent frankness. As between Science and the sacred volume which is the recognised depository of revelation, there may well be a truce. They do not come into the same territory. The ultimate truths of universal causation are not in the slightest degree ascertained by Science. The "promise and potency" of cosmic hypotheses have to be laid aside after a few noisy flourishes, as the exploded bladder-baubles of a revel which the participants in it would not be sorry to forget. While mystery surrounds impenetrably the origin of all things, Religion, hallowed by all the sacredness of immemorial antiquity, and justified by the peerless sanctity and beneficence of its ethics, is entitled to warn off authoritatively all rude assailants of a faith which mere scientific leaps and bounds can never shake. But there can be no truce or parley between the Bible and literary Criticism; nor would any sane Christian desire it.

Whatever else the Bible is, it is a collection of books. There is little obscurity about their literary history. There is not even a church theory which protects them from scrutiny, or avers that they have been sheltered from ordinary literary vicissitudes. Sooner or later the fact will be familiar, that as books, whatever their origin and innate or miraculously continued power, they must be reviewed and collated, annotated and explained. Better sooner than later. The results will probably not be unacceptable to the orthodox—or, at least, to those of the orthodox who are incapable of immuring themselves in an irrational twilight of untenable and arbitrary pietism. In fact, one of the first results of a sound general application of historical Criticism to the Scriptures would be to remove, or at least to remove the pressure of, the seeming antagonism between scriptural Theology and Science. But whatever the result may be, the fair and reverential application to the Bible of the Criticism

to which all books as books are liable, must be acquiesced in by all educated Christian men and women. It is the natural function of their teachers to accept the situation, and to superintend the process, so far as it may fitly and profitably take place in connexion with Christian ordinances.

In all subjects much good may be done in a quiet way by importing into every sort of education, whether juvenile or adult, those habits of fair judgment on the merits, of warm appreciation of excellence, of moderate but decisive condemnation of faults, of tolerant consideration of surrounding conditions and available materials, of eager development of rudimentary ideas, which entitle Criticism to its high Place and Power. Where there is true Criticism, superstition and prejudice have little chance. The mechanical must there give way to the vital forces. The arbitrary cannot remain on the level of intrinsically reasonable and reasoned principles. In political philosophy, where Criticism has play, there can be no childish impatience when the time is not yet for change; when the circumstances are not compatible with the highest good; when the men are not there, or are not powerful enough for progress: while, equally, in practical politics, sound Criticism will indulge no weakness for mere interested sloth or resistance, no toleration for prescription in the abstract—will countenance no loathsome sacrifices to ignorance, or passion, or vanity; will spare no prejudice, especially no national prejudice, and most especially no insular prejudice, which stands in the way of the utmost universal benefit. Hope on, hope always, while you work with open minds for the good of mankind, is the teaching of Criticism, as it is the inspiration of Public Spirit. Harriet Martineau, recording one of the most promising but disappointing epochs sketched by her faithful pen, has taught us a great lesson of all Criticism—a lesson not peculiar to the political

sphere. "It is true," she says, "that we look back upon the wisest and most earnest men then active in that field, as upon children planting, and watering, and setting their gardens to rights in a new burst of sunshine, while we from the summit of futurity perceive how the water-spout is hurrying on which is to tear up everything and leave all waste. But we see, also, that the more complete is the waste, the more thorough will be the renovation, and that perhaps the giddy and wrangling children may come back to their work with a better knowledge and a more rational expectation."

Such is the common, happy prospect of mankind—a prospect undisturbed by the many evils and degeneracies which defile the stream of time—a prospect not conjured up by the wild aspirations of enthusiasm, nor seen by superstitious eyes in the dull crystal of imaginative ignorance—a prospect neither near nor hopeless—a prospect for which Science and Benevolence work hand in hand, with Criticism to regulate their labours; to applaud the great intellects which lead and guide them; to conjure into visible presence yet richer and more glowing tints than even Poetry or Philanthropy can deck the fair western horizon of the world withal, as the evening of to-day's toil sinks amid splendid promises of to-morrow's well-being.

> There lives a light that none can view,
> Whose thoughts are brutish: seen by few.
> The few have therefore light divine;
> Their visions are God's legions.

If I have endowed that hard word Criticism with a sense and spirit not always identified with it, it is because I see in it an influence stealing into the mind and life by the contemplation of good examples and great principles; and because it were profane to doubt and graceless to ignore the good it does, and the infinite and endless blessings it must confer.

MONEY, COIN, AND CURRENCY.—REMARKS ON SOME RECENT FALLACIES CONNECTED THEREWITH.

By J. A. PICTON, F.S.A.

After all that has been written on the subject of money and currency, particularly by writers of such eminence as Adam Smith, John Stuart Mill, J. R. McCulloch, Wm. Stanley Jevons, and others, any further discussion might seem superfluous. It might reasonably be thought that the question was exhausted, and that its true principles were established on a basis so firm and stable as to preclude any further controversy in all time to come. And yet it is not so. Fallacies which it was supposed had been extinguished for ever, reappear from time to time with a vitality derived from their very absurdity. Principles which had become so familiar as to pass for axioms in political economy, are questioned with an audacity which only ignorance could inspire.

> "The times have been
> That when the brains were out the man would die,
> And there an end; but now they rise again,
> And push us from our stools."

If may not, therefore, be altogether a work of supererogation if we occupy a short time in examining the foundations of monetary science, and the system which has been reared thereon, testing their stability, and inquiring to what extent, if any, the various objections and proposed alterations in our monetary system are based on reason and adapted to the present time. When we find the Chamber of Commerce of

the second commercial town in the empire, in its published documents, ignoring what has hitherto been considered one of the simplest elements of economical science, viz., that :—

"The real value of a thing
Is just as much as it will bring,"

and giving currency to the theory that money is an abnormal article not subject to the ordinary principles of supply and demand, it is clear that there is still scope for discussion, and that it is just possible that an entire revolution may be at hand in our general monetary arrangements. There are also other questions connected with the circulation, on which writers of high authority are not entirely agreed. I propose, therefore, to take a rapid review of the whole subject, dwelling upon those points on which difference of opinion exists.

In the first instance it may be necessary to define the terms employed. In ordinary loose popular phraseology, *money* means circulating medium of every description, and the capital also which that circulation represents. Hence, as we shall see hereafter, there arises a confusion of ideas which leads to very erroneous conclusions. Money, in its proper sense, is the term for any commodity having in itself an exchangeable value, which is adopted as a medium or measure in the exchange of other commodities. We give the name of *coin* to pieces of metal bearing an authoritative stamp of their weight and purity. *Currency* consists not only of money, but to a far greater extent of promises to pay money, the ultimate basis being the prospect nearer or more remote of the conversion of the promises into hard cash.

Let us first consider the nature and functions of money. It is defined by McCulloch as "the name given to the commodities or articles which the people of different countries

universally accept, either voluntarily or by compulsion, as equivalents for their services, and for whatever else they may have to dispose of."* This definition is rather cumbrous, and does not express the peculiar function which money discharges. In a time of famine, or during the siege of a city, everybody would gladly give their services for food, without any intermediary, but this would not make the food into money. A more succinct definition, which covers the whole ground, would be that "money is that portion of the wealth or capital of a state which is adopted as the medium of exchange." This need not of necessity consist of the precious metals; any commodity in general demand would answer the purpose. In the pastoral or agricultural stage of society, cattle and sheep were the most obvious commodities for the purpose. In the *Iliad* and *Odyssey*, the value of works of art in gold and silver is estimated by the number of oxen given in exchange. In the 6th book of the *Iliad*, where Glaucus and Diomed exchange armour, the poet tells us that that of Glaucus cost one hundred oxen; that of Diomed only nine. In the description of the ægis of Pallas, we are told that each of the golden tassels by which it was decorated was worth one hundred oxen.† Various substances have been employed in different ages and countries as money; corn, the skins of animals, dried fish, cowry shells, salt, brass pans. In the central regions of Africa, at the present day, the only currency generally accepted consists of pieces of cloth of a certain description and length. The metals, however, from their compactness, durability, and general usefulness, were very early found the best adapted for the purpose.

* *Ency. Brit.*, article "Money."

† Precisely the same state of things exists at the present day in South Africa. Amongst the Zulus every thing is appraised according to the number of cows it is worth. In the purchase of a wife the price varies from one cow upwards.

Iron is said to have been used as money by the Spartans, and Pliny tells us that the first money used by the Romans consisted of copper bars. But of all the metals, gold and silver have been universally found the most suitable for money. Silver appears to have been the first so applied, in the first instance by weight, as when Abraham purchased the field from Ephron the Hittite, he weighed to him four hundred shekels of silver. This seems to have borne some stamp or mark of its purity, as it is described as "silver current with the merchant."* Jacob, however, when some time afterwards he bought a piece of land at Shechem, paid for it in lambs.† According to Herodotus, money was first coined by the Lydians. Silver was the first metal adopted for the purpose, gold being principally used for ornaments and jewellery.

The term *money* is derived from the Romans, who established their mint in the temple of Juno *Moneta*, or the admonisher. Amongst civilized nations, the convenience of coin once adopted, led to the supersession of all other kinds of money, so that money and coin became in common parlence identical terms.

There is a strange fallacy lurking in the minds of many, and sometimes publicly developing itself, that money is not a commodity subject to the same laws of supply and demand as other articles of commerce, but something quite abnormal, subject to control by the powers that be, and liable to be altered in its value by legislative enactments. M. Henri Cernuschi says:—"C'est la fonction légale de monnaie qui donne grande valeur au métal; c'est le législateur qui attribue au métal cette fonction. C'est donc le métal qui doit obéir au législateur, et non le législateur au métal."‡ This delusion has been fostered by the loose language employed by some

* Gen. xxiii. 16. † Gen. xxxiii. 19.

‡ Article in the *Siecle* newspaper, April, 1876.

writers. Thus M. Jean-Baptiste Say, probably the highest authority in France on questions of Political Economy, speaks as follows:—"Beaucoup de personnes confondent la monnaie d'un pays avec ses capitaux. . . . Entre les capitaux et les monnaies il n'y a de commun qu'une qualité. C'est la valeur. Du reste, il y a beaucoup de valeurs qui ne sont pas capitales, et beaucoup de capitaux qui consistent en tout autre choses qu'en monnaies." * This is no doubt strictly true, but without due consideration it might lead to the conclusion that money is not capital, and consequently not subject to the ordinary laws of exchange.

In order properly to understand the functions which money discharges in the transactions of life, it is necessary to recur to first principles. All value is ultimately, as its final cause, based upon labour, or skill, which is only a higher form of labour. All wealth is accumulated labour. It is labour which gives its value to every article prized by mankind. Even rarity, which enters as an element enhancing the value of many objects greedily sought after, may be resolved into the same element, since the rarer a thing is, the greater the amount of the highest skill which must have been expended in its production, if a work of art, or the greater the labour on the chance of finding it, if a natural substance. At present prices and rate of remuneration an ordinary artisan would for about a fortnight's labour be entitled to a quarter of wheat. In a state of society in which no coined money existed, he might not immediately want the wheat, and could store it up for future consumption, and according to the use he makes of it, in modern economic phraseology, it would go by different names. As he expended a fortnight's labour in obtaining it, he could subsidise the services of another man for an equal period. In this point of view his quarter of wheat is to that extent *wealth*. He might use the wheat as

* *Cours Complet d'Economie Politique*, 2 vols. Paris, 1852.

seed corn if he had land suited for the purpose, and obtain a profit by the increment. In this case, his wheat, without ceasing to be wealth, becomes *capital*. Or he might exchange the wheat for some other article which had cost about the same amount of labour. The wheat, then, to all intents and purposes, discharges the functions of *money*. There is thus no radical difference of nature between wealth, money, and capital. They equally represent and give the command of a certain amount of labour or skill. The only difference is in their application. Our present concern is with *money*. I have already said that the word is used in two senses; first, for the coined gold and silver which constitute the basis of our currency, and, secondly, for the accumulated wealth constituting the floating capital of the country, which is the life-blood of our commercial transactions. Let us consider the first in order.

The nature and functions of money have never been more lucidly explained than by Jno. Stuart Mill, in his *Principles of Political Economy*.* The value or purchasing power of money, like that of every other commodity, depends in the first instance on demand and supply. But demand and supply in regard to money are the converse of those applying to other commodities. If I sell a pair of boots for a sovereign, and with the sovereign I purchase a hat, it is precisely the same thing as if I exchanged the pair of boots directly for the hat. The transaction supposes the value of the labour expended on each article to be equal, and that the outlay of labour in procuring the gold and coining the sovereign are also equal. Supposing that, by some improvement in machinery, the quantity of labour required to make a hat were reduced one-half, it is clear that the value of hats would be reduced in like portion, for any attempt to keep up the price would be neutralised by competition. The labour

* Book iii., chapters 8, 9, and 10.

expended on the boots and the sovereign continuing the same, I should get by the sale of the boots two hats instead of one. If the hatter, under these circumstances, wanted a sovereign, he would have to give for it two hats instead of one as previously. We should say that hats are cheaper, but in relation to this transaction it would be quite as correct to say that gold or money had become dearer. At any given period there is a certain quantity of coined money in the country, and certain quantities of various commodities, and prices regulate themselves accordingly. If from any cause the quantity of coined money were increased, say to double the amount, without a corresponding increase in the quantity of commodities, the money would sink to half its previous value; or, in other words, prices would rise to the same extent. A hat which cost a sovereign would now bring two sovereigns. If, on the other hand, half of the coined money were to be sent out of the country, or from any other cause were withdrawn from circulation, the converse of this would take place; one sovereign would do the work of two; prices would fall one-half. The hat which cost a sovereign would now be obtained for ten shillings.

It will thus be seen that price and value, which are often confounded together, are in reality very different things. Price, like an algebraical formula, is a mere instrument of calculation. If by a certain amount of labour I can procure a hat or a pair of shoes, it is a matter of indifference what the nominal price may be. Value is represented by the quantities of commodities interchangeable one with the other, and is determined by an infinite variety of circumstances constantly fluctuating, but ultimately resolving themselves into labour or the cost of production. I have mentioned what the effect on prices would be from an increase or decrease of the quantity of money in circulation. But this is not the only or the principal cause of variation of price. The

quantity of each commodity in the market, or the relation of supply to demand, has an equal influence on prices, with this difference, that in this case it is the actual value which is affected, of which price is merely the expression. For instance, let us suppose wheat to be at forty shillings a quarter, and in the course of a given period it rises to sixty shillings. This may arise from either of two causes. The quantity of money in circulation may have increased one-half. In this case prices would be affected all round, but the value in reference to other commodities would remain just as before. Or it may be that the supply of wheat has fallen off owing to bad seasons at home or abroad. In that event, the actual value would be affected, of which price is merely the expression.

Money, therefore, rightly viewed, is merely the medium of exchange. Its functions are, to express by a kind of shorthand, the relative value of one commodity compared with that of another. Or it may be considered as performing the same office in regard to commodities which a bank does in regard to money itself. One merchant, for instance, has a quantity of cotton in one warehouse, silk in another, sugar in a third, and so on. Another has no goods, but there stands to his credit at the bank a sufficient sum to purchase the produce belonging to the other. It is clear that it is the same thing as having the goods, with this advantage, that his money is applicable to be expended in any description of commodities which may appear advisable. So in regard to money itself. It is a certificate of so much accumulated labour, which may be exchanged for any article of human convenience.

Under the ordinary state of things, the quantity of money in any country regulates itself. Silver and gold being commodities having an exchangeable value, dependent ultimately on the cost of production, are subject to the ordinary laws of supply and demand. Gold being our present legal tender,

when imported is usually taken to the issue department of the Bank of England, and coined or exchanged for coin at a fixed ratio, and becomes a part of the circulation. If at any time the amount of this coin in circulation is greater than the necessities of the country require, it becomes of less exchangeable value. Its purchasing power is reduced, which is felt in the advance of prices. In the balance of transactions with other countries, coin being thus cheap and goods dear, the gold is drawn away and sent abroad until the equilibrium is restored. This process is self-acting. It is liable to be temporarily disturbed by a variety of causes, but it always tends to right itself. *

These principles of the nature and use of coined money appear clear and simple enough. They are now generally admitted, and allowed to take their course without control or interference. This was not always so. The meddling of governments with the currency, sometimes dishonestly, and at other times with good though mistaken intentions, has done grievous harm, and even now many erroneous notions are afloat which, if allowed scope for development, could only end in disappointment and wrong. Let us glance at a few of them.

One of the earliest fallacies, which is not yet entirely exploded, is that it is the Government stamp which imparts its value to the coinage; that it is in the power of the State, by a simple enactment, to raise the exchangeable value of coined money beyond its worth in the market as bullion.

* "La quantité de la monnaie que l'on verserait ne changerait rien au besoin de monnaie qu'éprouve la nation. Elle n'aurait toujours à offrir contre de la monnaie que la même quantité de marchandises, et demanderait à en acheter la même quantité; conséquemment, si l'on jetait dans la circulation de la France 4 milliards de francs, au lieu de 2 milliards que, dans notre hypothèse elle possède maintenant, ces 4 milliards ne pourraient toujours acheter que la même quantité de biens. La seule difference qu'il y aurait, serait que l'on donnerait 2 francs où l'on en donne un."—Jean-Baptiste Say, *Cours d'Economie Politique*, i. 389.

This in the middle ages was a fruitful source of mischief, which has left its record in the denominations of our coinage. The English pound and the French *livre* were originally a pound troy of silver, of which the solidus, or shilling, formed the twentieth part. As the Sovereigns had the control of the mintage, at various emergencies they clipped or debased the coinage, compelling their subjects to accept it at the full nominal value. This had the double result of flooding the country with a circulation not needed at home, and reducing its value in purchasing abroad. To such an extent was this carried, that in England the intrinsic value of the coinage was eventually reduced to about one-third of its nominal value; whilst in Scotland, the pound was actually brought down by the successive tampering of its needy rulers to one-thirty-sixth part of its denominational value.

Since the time of Queen Elizabeth this abuse has been stopped, but the ideas which prompted it still exist, and manifest themselves in various ways.

It has been argued, for instance, why have metallic money at all? Since money is merely the medium for the exchange of other commodities, and is subject to serious loss by wearing, besides the interest on the large amount invested in coin, why cannot cheaper substances be employed, or, since money is only the representative of the property of the country, why should not a simple certificate, bearing the Government imprimatur, suffice for all the purposes of commerce? The answer is very simple. The system fails in two essential elements. It would not be self-regulating, and the money would have no exchangeable value abroad, or if it had, it would be at such a discount as to paralyse all trading operations. The issue of such a circulation would be in the hands of the Government, who could enlarge or contract it at pleasure, without reference to the interests of the community, or, under a mistaken sense of such interests, might,

with the best intentions, do infinite mischief. The experiment has been tried, with results of a very disastrous character. In France, in the year 1790, under the severe pressure caused by the events of the Revolution, through which the gold and silver coin was rapidly leaving the country, the project was carried of issuing certificates based on the security of the forfeited estates of the clergy and emigrants, the holder of which might use them as money, or claim the property which they represented. As necessity required, these *assignats*, as they were called, were issued to such an extent that they sunk rapidly through various stages of decrease, until they fell to the one hundred and fiftieth part of their nominal value in silver, and ultimately became utterly worthless.

It seems, then, clear that, in order to perform its proper functions as a measure of mutual value, the money of a country must be composed of a material having intrinsic or exchangeable value in itself, independent of the stamp or authority by which it circulates, and is thus subject to the same fluctuations in value arising from the laws of supply and demand which attach to every other commodity. This may at first sight appear a disadvantage, but it is unavoidable. There is not, and never has been, any permanent unchangeable standard by which one commodity could be compared with another. It is as if we had to measure comparative quantities by a scale which is, in itself, changeable and fluctuating. It is, however, by this very quality that it answers its purpose in human affairs, like a fertilising stream, always seeking to find its level, forsaking the locality where it is in excess, to fructify the regions where a supply is required. Coined money thus can never, except under special circumstances, and to a very trifling extent, exceed or fall short of the value of the bullion contained in it. At the present day a pound troy of standard gold is coined into

46·725 sovereigns. If the same quantity were coined into forty-seven sovereigns, there would be a depreciation in the value of ·275 in each pound of gold coined, or ·588 per cent., being a trifle in each individual sovereign, but in the coinage of a million, amounting to the sum of £5,880. Such depreciated coinage might answer very well confined within the limits of the country where it was issued, but if a million was required to be sent abroad, it is evident that, sooner than submit to a loss of £5,880, the parties would purchase uncoined bullion for the purpose. The coined gold then would permanently sink in value in the same proportion. Suppose, on the other hand, that the pound troy was coined into only forty-six sovereigns. Each sovereign then would be worth in bullion nearly twenty shillings and fourpence, at which rate it would be so profitable to convert them that they would soon be sent abroad, or melted down. Coined money, thus, has a wonderful power of adaptation to the wants of the community, precisely in the same way as sugar, cotton, or coffee rise and fall in price, increase or diminish in quantity, according to the cost of production and the demand for them in the market.

It is sometimes asserted that the quantity of coined money in a country has a powerful effect in stimulating trade and facilitating the operations of commerce. There is a certain element of truth in this, but it is to a very limited extent. The quantity of coin in circulation is rather the effect than the cause of activity in the industry of a country. Suppose a country, in its normal condition of manufactures and commerce, provided with a circulation sufficient for its ordinary wants, based upon a metallic coinage either of gold or silver. The opening out of new supplies of the precious metals pours into its markets an abnormal supply of bullion. Prices of goods are immediately raised, partly from the increased supply of coin, and partly from the increased demand for

manufactures in exchange. The manufacturers are the first to feel the benefit, since some time is required for the change to reach food and the necessaries of life. A season of prosperity sets in. The increase of business requires an increase of current money to carry on its operations; but the time at length arrives for a reaction. Production is stimulated by high prices to an extent far beyond the legitimate demand. Concurrently with this the wages of labour and the expenses of manufacture have enormously increased. The high prices at home check exportation abroad, and a collapse, aggravated by other circumstances to which I shall shortly allude, takes place, until the fever has abated, and matters resume more nearly their ordinary condition. During the continuance of the stimulus and afterwards, so far as the increase is permanent, the enlarged extent of business will require an enlarged extent of circulation, the more so that, when prices are high, a larger amount of coin is requisite as a basis of operations. This, in time, finds its level, and any excess in its amount not being employed with advantage is speedily withdrawn. No external influence can keep up a circulation of coin which is not required by the wants of the community. The expense of its maintenance is a sure check against its excess.

We have already seen that money, to perform its proper function, must consist of a material having an intrinsic or exchangeable value in itself. The question then arises, can there be several commodities employed for this purpose circulating in the same country at the same time? I have endeavoured to shew that money is the regulator of nominal price, but not of exchangeable value, and that prices must vary according to the proportionate quantities of money and other commodities in the market. This imparts an uncertainty and fluctuation for which there is unfortunately no remedy. It may be illustrated by supposing that cloth, for

instance, remaining always at the same nominal price, had to be measured by a yard-stick, varying in length according to the quantity in the market. A little consideration will shew that this would have precisely the same effect as if the variation was in the price, the yard-stick continuing the same length. Supposing it possible, persons would soon become as accustomed to this as they are to the present state of things. But imagine there were two yard-sticks employed, not only changing themselves in length from day to day, but never exactly corresponding with each other. The confusion arising therefrom would sooner or later compel the suppression of one or other as any standard for buying or selling.

During a long period in the history of the world, silver and gold have been the only substances employed as coined money except for small change. Each of them is subject to the ordinary laws of supply and demand, in addition to which the spasmodic and irregular action, according as the sources have suddenly expanded or contracted, has imparted a fluctuation in their value greater than that of most other commodities. There is no natural relation in their respective values. They have constantly varied in every period of our history. In the time of Edward I., when gold was first coined in England, the proportion of value was ten to one. In the reign of Henry VIII. it had fallen to five to one. From that time there has been a slow but gradual depreciation in the relative value of silver, until at present, with silver at four shillings and twopence per ounce, the proportions are 18·6 to 1.

The inconvenience of this uncertain relative value of gold and silver was very early felt, and was countervailed to a certain extent by royal proclamations from time to time, fixing the rates at which gold coins should be exchanged for silver. In 1664, the guinea was first coined. From that date to 1717, no relative value was fixed by authority, the

public being left to make their own arrangements; but, at the latter date, it was enacted that the value of the guinea should be twenty-one shillings in silver. As the pound of silver was then coined into sixty-two shillings, the proportionate value was 15·7 to 1. In this calculation, however, silver was somewhat undervalued. The consequence was that the silver coinage as it came from the mint was bought up with gold and exported, none being left but the worn and debased coin. Gold was thus, for all practical purposes, the standard of price. In 1774, it was enacted that silver by count should not be a legal tender for more than twenty-five pounds, all above that amount being reckoned at five shillings and twopence per ounce. In 1816, the silver currency was reduced in value by coining sixty-six shillings instead of sixty-two out of the pound troy; but it was to be a legal tender to the extent of forty shillings only. It will thus be seen that, with the exception of the fifty-seven years from 1717 to 1774, there has been no attempt in England to fix a permanent ratio between the value of silver and gold coinage, and that the attempt then made resulted in failure, and had to be abandoned for a standard in gold only.

In France the attempt to adjust the relative values of gold and silver took an exactly opposite course. In 1785, eleven years after the adjustment of the coinage in England, a recoinage took place in France. In the proportion then settled by the mint, the Louis d'Or was rated at twenty-four livres, when it was really worth twenty-five livres ten sols. Every payment, therefore, made in gold, cost the debtor six and a quarter per cent. beyond its value in silver. The consequence was, that no such payments were made; the silver was retained for the home circulation, and the undervalued gold was exported at a profit. Hence, down to a recent period, the circulation in France was almost exclusively silver. Circumstances have now changed; gold is again

in the ascendant, and has driven the silver out of circulation.

In Germany, and most other Continental states where the currency consists of coin, silver has been, until recently, the only standard. The change in Germany from silver to gold, by which eighty millions sterling of the former metal has been thrown on the market, has very seriously contributed to its depreciation.

The impossibility of preserving a fixed ratio between gold and silver coin, and keeping them both in circulation as a legal tender, is now almost universally admitted by writers on the subject. John Stuart Mill says:—"It appears that the value of money is liable to more frequent fluctuations when both metals are a legal tender at a fixed valuation, than when the exclusive standard of the currency is either gold or silver. Instead of being only affected by variations in the cost of production of one metal, it is subject to derangement from those of two." *

M. Say writes:—" C'est une entreprise superflue que de vouloir établir par les lois un invariable rapport entre des monnaies faites de deux métaux differents. Lorsqu'on fait dire à vos lois que quatre pièces d'argent de 5 francs valent autant qu'une pièce d'or de 20 francs, on leur fait dire un mensonge." †

These principles appear sound and even irrefragable, but either in ignorance or defiance of them, a school of economists has of late risen up, who preach the gospel of a bi-metallic currency as a panacea for commercial depression and manufacturing distress. In the words of Mill, "it is probable that, with most of its adherents, its chief merit is its tendency to a sort of depreciation, there being at all times abundance of supporters for any mode, either open or covert,

* *Principles of Political Economy*, 3rd ed., ii., 84.

† *Cours d'Economie Politique*, 3rd ed., i., 406.

of lowering the standard." The present movement had its origin with those who are interested in silver, and who have naturally felt discouraged at the very serious depreciation which has taken place in the marketable value of the metal. This arises not only from the increased sources of supply from the mines, but, to a great extent, from the demonetization of silver in Germany, and the tendency to a single standard manifested by most commercial countries. The authors of the proposed scheme wish to place silver side by side with gold in the currency of the world as a legal tender for all payments.

Several leading members of the Liverpool Chamber of Commerce have taken an active part in this agitation, and, under their guidance, the Council of the Chamber passed a series of resolutions, and sent up a deputation to the Government to present a memorial embodying their views, which are set forth in a Report, issued in March, 1879. I now propose to consider, as briefly as the circumstances will allow, the statements, arguments, and conclusions therein laid down. I can only, of course, take the salient points.

After drawing a gloomy picture of the serious depreciation in the value of silver measured by gold, they pass, among others, the following resolution:—"That the serious diminution of the world's money, caused by the disuse of silver, may in the future lead to frequent panics, through the inadequate supply of the world's wants."

The history of commercial panics shews that they have uniformly been the result of the collapse of inflated credit. It has been the panic which has caused the want of coin which at such times is hoarded and held. At a time of overtrading, prices rule high, and it becomes more profitable to export bullion and coin than to use it at home. Credit then supplies the place of coin; speculative transactions run up prices until the demand will no longer sustain them. The

tide turns, holders are anxious to sell, and prices fall more suddenly than they rose. The coin which has been sent away requires time to bring it back by the slow operation of the foreign exchanges, and a panic sets in, which can only be cured by the restoration of credit. At such times it would matter little whatever amount of bullion had been coined. In the rush of overtrading the larger part would have disappeared. Mr. Mill thus puts it:—"Every country (temporary fluctuations excepted) will possess and have in circulation just that quantity of money which will perform all the exchanges required of it; . . . and precisely because the quantity cannot be prevented from affecting the value, the quantity itself will, by a sort of self-acting machinery, be kept at the amount necessary for performing all the business required of it." Flooding the country with silver, therefore, would have the effect of raising prices until the surplus was sent away, and the circulation reduced to its normal condition. The "inadequate supply" of silver which is supposed to lead to panics is a mere figment of the imagination.

Coupled with this are a series of resolutions relative to the diminution of investments, and the uncertainty of the course of exchanges with silver-producing countries, affecting their power to purchase English manufactures, and curtailing the trade in English commodities.

All this is, doubtless, true. It only means that the price of silver has fallen in the market, crippling the resources of the producers and holders.

Another resolution attributes the great fall in the price of silver to the suspension of free mintage in France and the Latin States, and to the action of Germany in demonetizing silver. This is, doubtless, true; it simply amounts to this, that the price has fallen, through the commodity being no longer required to the same extent.

The next resolution informs us, "That the bi-metallic

system of France and the other States of the Latin Union, in conjunction with free mintage prior to 1875, tended to produce an equilibrium between the two metals, and to give stability to all exchanges between silver-using countries and England."

This resolution states as a fact what is notoriously incorrect. There was not, previous to 1875, in any country, and there never has been, an "equilibrium" between gold and silver. France, from 1785 down to the Californian gold discoveries, possessed a circulation almost exclusively silver; since that period gold has superseded silver for every purpose but that of small change. The coffers of the Bank of France are now teeming with silver bullion against the note circulation, yet the Government dare not issue it in the shape of coin, for fear of the serious results.* Every debtor would be able to pay his debts, contracted in gold or its representative, in a currency depreciated 20 per cent. Nominal prices would rise to that extent. Gold would be driven out of the market and disappear, and the foreign exchanges would be dislocated.

So much for the equilibrium in France. The other States of the Latin Union are even worse. Italy, nominally, may have a double standard, but her currency is almost entirely of inconvertible paper, which is at a discount of 10 to 12 per cent.

The gist of the whole report, however, is contained in the following recommendation:—"That a fixed ratio between gold and silver, in conjunction with unlimited freedom of mintage and the recognition of the two metals as full legal tender money, would, if adopted by the majority of the lead-

* On the 27th March last, the Finance Minister stated, in the French Senate, that the Latin Convention had suspended the coining of silver; that between 1850 and 1870 France had exported fifteen hundred millions of francs in silver, and she might hope for such a further reduction of her stock as would put her in a position to discuss the single standard.

ing monetary powers, including England and India, be adequate to restore silver to its former international value as money."

A further resolution winds up the series by recommending the Government to take measures to secure an international agreement to carry out the scheme. In reading this recommendation, and reflecting on its character and tendency, we are at a loss which to admire the most—the audacity of the proposal or its utter impracticability. The simple object aimed at, though veiled in a sort of euphemism, is to enhance the value of silver in the market. Why is silver, above all other commodities, to have such favour shewn to it as to set aside all the principles of supply and demand? The only ground on which the claim can be set up is that there is an excess of silver in the market, which has had the effect of reducing the price. Precisely the same reason might be given for fixing the value of iron, or copper, or any other commodity. The principle is that of protection in its worst form. The only parallel that can be found is that of the exploded corn laws, which fixed the price of wheat before importation could be permitted, but even then did not go so far as to attempt to fix permanently the exchangeable value of the article. If silver is thus to be dealt with, why should not sugar—in favour of which a feeble attempt is being made—have the same favour? Nay, why should we not return to the legislation of the middle ages, and fix by statute the wages of labour and the price of bread? Once committed to a false principle, there is no limit which can be assigned to the mischief which might ensue.

Looked at from another point of view, it does not require much argument to demonstrate the impracticability of the scheme. The object is to fix by statute a definite and permanent ratio between the exchangeable value of two commodities which in point of fact never has existed, and, in the

nature of things, never can exist. We might as well attempt to secure a fair wind by nailing fast the weather-vane. The exchangeable value of every commodity is regulated by its quantity and the demand for it, a law of nature which no human power can contravene, and which is in no way altered by the fact of the commodity being used as a medium of exchange or money. In the case of a single standard, its rise or fall in value is shewn in the rise or fall of prices; in the case of a double standard, there would be two processes going on at the same time, the continued existence of which would be impossible—one would inevitably destroy or eliminate the other.

It is strange, seeing that the sole object of the Council is to raise the value of silver, not a word is said about it in any of the documents. They modestly confine themselves to the proposal of a "fixed ratio" between the two metals. Supposing the plan adopted, what is that ratio to be? At the present market price of silver, about 4s. 2d. per ounce, the ratio would be 18·6 of silver to 1 of gold, and matters would remain just as they are, with this disadvantage, that if silver went up in price, which it very likely might do, the coin, being of less nominal value than the bullion, would speedily disappear from circulation, or would have to be adjusted from time to time according to the state of the market. Whether that state of uncertainty and perpetual meddling would facilitate commercial transactions is a question not requiring much argument.

This, however, is not what is meant by the resolution; for its real scope and aim we must turn to the accompanying documents, and notably to the pamphlets issued by M. Henri Cernuschi, the apostle of the new financial era. We there find the proposal that the relation between the two metals shall be fixed for all time at 15½ to

1,* or, in other words, that the nominal value of silver coin shall be raised 20 per cent., with unlimited power of increasing the quantity. Now here is a dilemma, out of which I do not see a way of escape. The silver coin so raised in value by a stroke of the pen, will either be a legal tender or it will not. If it is to be so, it is simply an act of confiscation to the amount of 20 per cent. on all property and debts. A man owing £100, having the option of discharging it either in gold or silver, will of course choose the cheaper metal, thereby defrauding his creditor of £20. So also with rents and all other obligations. What individuals would do, the State might also do, and thus the interest on the national debt be reduced one-fifth. It is in vain to argue that these results might possibly not take place, for the very object of the proposal is to enhance the purchasing power of silver. So it has been understood in the United States, where the disciples of M. Cernuschi have gained a temporary triumph by the passing of the Bland Silver Bill, which gives unlimited power to coin silver dollars of 412½ grains, which is about five shillings an ounce, "the Secretary of the Treasury being ordered to pay out without discrimination the standard silver coin, in the same manner as the gold coin, in liquidation of all kinds of money obligations against the Government." † The national debt having been contracted in gold, this measure at

* "Si une loi uniforme établissait dans les grands états, la même relation entre le poids de la pièce d'or et le poids de la piece d'argent, aucune modification de valeur ne pourrait pas se produire nulle part entre les deux metaux. On propose le 15½ universel, parceque le 15½ existe déjà en France et ailleurs."—*Le Bimetallisme*. Paris, 1876.

† See notice in the *Times*, May 26, 1879. In the *Times* of March 31st it is stated that 21,061,274 Bland dollars had been coined, but only 6,005,076 had been put into circulation. The problem of the Treasury was what to do with the fifteen millions the public refuse to take, the indisposition to receive debased dollars being so plainly indicated. Since that date, the Republican State Convention of New York have passed resolutions disapproving of the action of the Congress, and that all attempts to deteriorate the specie standard should be firmly resisted.

once confiscates it to the amount of 20 per cent. It is probable, however, that either the Senate or the President will have the good sense and honesty to prevent this Bill becoming law. In the discussion it was proposed that silver should be a legal tender for all debts, private as well as public, but this was rejected, the project being at present confined to robbing the public creditor. When it was proposed that the members themselves should be paid in silver coin, the motion was ruled to be out of order.

This, then, is one horn of the dilemma—confiscation, if the measure were enforced. Some advocates, however, shrink from this extreme proposal, and would make the acceptance of silver optional. In this case it needs no argument to prove that the bi-metallic system would be an utter failure. No man in his senses would accept £80 in payment of a debt of £100, unless as a composition from an insolvent. On one or other of these two horns the bi-metallist must impale himself.

But it may be argued that a free mintage and optional use of silver coin could do no harm, and might be tried as an experiment. I reply, that it would do no good and might do infinite harm. The gradual infiltration, so to speak, of the inferior metal into the circulation would impart an uncertainty into the ordinary transactions of life which would be very injurious. There would be two prices for every article of value, one in gold and one in silver, and the depreciation of silver, by raising the prices of the necessaries of life, would act very disastrously on the poor.

I have dwelt at some length on this Bi-metallic question, seeing that the centre of the agitation lies within our own community. There is not the remotest prospect of the scheme being adopted, the tendencies being all in the other direction; but it is provoking to see the names of men honoured in our commercial circles giving sanction to such a chase after a mere Will-o'-the-wisp.

Another fallacy, which meets us at every turn, is the loose and confused notions entertained about money being cheap or dear. The word *money* is used, in common parlance, in several senses; its primary meaning is that portion of the wealth of a country which is used as a medium of exchange. This, for many ages, has consisted of gold and silver. In another sense it is used for the general circulation, including bank-notes, bills, and promises to pay of every description. It has also a third common signification, that of the floating capital of a country waiting for employment in any direction.

In the first sense, that of coined money, its rise or fall is indicated by its higher or lower exchangeable value, dependent on the quantity in existence, which is ultimately determined by the cost of production. Every community will possess of this just as much as its wants require, and no more. If coin is scarce, prices will be low. Purchasers are then attracted by lowness of price; coin flows in until an equilibrium is established. If the coin is in excess, prices are high. The demand falls off, and the coin is carried to a better market. Under a system of free intercourse the proportion regulates itself. Cheapness of money means dearness of price; cheapness of price means dearness of money. In the middle ages an absurd notion prevailed, that the wealth of a country consisted in the abundance of gold and silver, and various laws were passed to limit or prohibit the exportation of money. These laws were so easily evaded as to be almost inoperative. In so far as they were effective they did mischief, as, by raising the home prices, they checked and hindered foreign commerce; but there is a wonderfully recuperative power in industrial operations. The same plethora of coin which raised the price of home commodities also increased the value of imports from abroad, so that instead of sending coin to purchase the wool fells,

corn, &c., of England, they sent wines and manufactures, with the products of which they bought the produce for export.

In the second sense, the term money includes all bank notes, cheques, and bills, which are really promises to pay in coin, and with the exception of Bank of England notes, which actually represent bullion, are based upon credit. In this way a comparatively small amount of specie is, with perfect safety, made a basis for an enormous superstructure of credit. The quantity of coin in existence in the country at one time it is not easy to determine. The amount in the vaults of the Bank of England, by the latest returns, was thirty-five and-a-half millions, and, probably, the coin in circulation will amount to about double that quantity, making about 105 millions in all. Now, let us see how the paper circulation compares with this. The note circulation, for which there is no reserve of bullion, amounts to twenty millions. The business done at the London clearing-house in exchanging cheques and bills amounts to about five thousand millions a year, without the use or employment of a single bank note or sovereign. It has been calculated that the amount of paper circulation constantly existing amounts, on the average, to at least five hundred millions. All this vast superstructure is entirely based upon credit. Every bill and cheque is a promise to pay coin; but was all demanded at once, there would not be coin enough in the world to satisfy the demand. Now, in case of a panic, from whatever cause, there is a general tendency to realise. Those who have coin, hoard it; those who are asked to lend, decline, except at very high rates, and, unless abnormal means are taken to restore credit, a general bankruptcy might ensue. In this case the dearness of money means restriction of credit.

There is a third sense in which money is said to be dear or cheap, that is, when it is used as identical with capital.

The capital of a country consists of that portion of its wealth which is devoted to the production and distribution of commodities. J. S. Mill says:—"Capital, by persons wholly unused to reflect on the subject, is supposed to be synonymous with money. . . . Money is no more synonymous with capital than it is with wealth. Money cannot, in itself, perform any part of the office of capital, since it can afford no assistance to production. To do this it must be exchanged for other things."* Professor Jevons says:—"Capital, as I regard it, consists merely in the aggregate of those commodities which are required for sustaining labourers of any kind or class engaged in work."† To the same purport are the views of Ricardo, McCulloch, and Professor Fawcett. But although money is not identical with capital, it is its representative. Capital, like every other human possession, has an exchangeable value, and in the present state of society these exchanges can only be effected through the medium of money. We have already seen that the quantity of coin in a country is self-regulating. No power can retain in circulation a greater quantity than just suffices for the operations of commerce. On the basis of the coin or bullion is raised the superstructure of the floating paper circulation. This circulation again is used to represent the tangible capital in all business affairs; but we must not forget that the real transaction is not in the money or currency which is handed over, but in the wealth which it represents. If a man hires a farm on the *metayer* principle of paying the landlord one-half of the nett proceeds in kind, and that share brings in an income, say £200, it is precisely the same thing as if he paid £200 rent in money. In every transaction of borrowing on tangible security the principle is the same. If I erect a manufactory, and borrow on its security £10,000, for which

* *Political Economy*, i., 67, 3rd ed., 1852.

† *Theory of Political Economy*, p. 248, 2nd ed., 1879.

I pay £500 a year, it is, so far as political economy is concerned, the same as if my creditor had built it, and let it to me for that sum. Again, the rent or interest which I pay is merely the representative of a certain proportion, real or supposed, of the profits of trade which might be paid in kind. In principle there is not a money transaction in real capital which could not be carried on by barter, supposing no money was in existence.

The loan market on security, thus, is regulated, not by credit, nor by the quantity of money, but by the abundance or deficiency of those commodities which constitute capital. When they are abundant the amount paid for their use will be low; when they are scarce the rate will be high. The best proof of this is the phenomenon often exhibited of a high rate of interest in the discount market, where money is said to be dear, concurrently with a low rate on loans advanced on good security. The phrase cheap or dear money thus may be used in three senses, and to be understood requires it to be known in which sense it is employed.

To avoid extending this Paper beyond reasonable limits, I must leave untouched the wide field of paper currency and credit, and other collateral questions.

There is one other fallacy to which I desire to call attention, as it has been of late brought prominently forward in a way to excite very gloomy apprehensions for the future of our country. I mean what is called "The Balance of Trade," a tradition inherited from our ancestors, which in times past has worked infinite mischief, but which is now reduced to a mere phantom, which, on closer examination, vanishes into thin air. The theory is this: that money or coin is the only representative of wealth; that the more of this a nation possesses the richer it will be; that, in order to attain this end, the exports should always exceed the imports, the balance being supposed to be paid in coin. To promote this influx

of the precious metals was the constant aim of our commercial legislation, the effort being continually made to encourage our own manufactures, and to discourage as much as possible those of other countries. At the first blush there seems a flaw in the argument. Supposing that we exported ever so much, and received the whole returns in coin. According to the theory we ought thereby to be placed on a pinnacle of prosperity. But what should we do with the money when we got it? It would neither feed nor clothe us, nor procure for us the necessaries and comforts of life, without being again paid out. The only possible result would be, so long as we retained it, to raise the price of every commodity, and thereby check the very exportation so much desired. One or two instances may be alluded to. During the eighteenth century, when the absenteeism of Irish landlords was at its height, the produce of the country was exported to a very large extent, and principally paid for in money. If the balance of trade theory was sound, Ireland ought to have been, under these circumstances, one of the most prosperous countries in existence, whilst it is notorious that she was one of the poorest and most miserable, the money so received being paid into the coffers of the landlords and spent abroad. Take, again, the example of Spain, which, from the discovery of the silver and gold mines of America, received, in the sixteenth and seventeenth centuries, fabulous quantities of the precious metals, which never made her rich, but proved the precursors of decay and ruin. The mercantile classes very soon found the evils of this state of things, and remonstrated from time to time with partial success, but with no permanent effect. Adam Smith says:—"The two principles being established that wealth consisted in gold and silver, and that those metals could be brought into a country only by the balance of trade, or by exporting to a greater value than it imported, it necessarily became the great object of

politicians to diminish as much as possible the importation of foreign goods for home consumption, and to increase as much as possible the exportation of the produce of domestic industry. The two great engines for enriching the country, therefore, were restraints on importation and encouragements to exportation." Smith, a hundred years ago, saw clearly the evil of this state of things, and advocated freedom of trade, but with no expectation that it would ever be adopted. He says :—" To expect that the freedom of trade should ever be entirely restored in Great Britain is as absurd as to expect that an Oceana or Utopia should ever be established in it. Not only the prejudices of the public, but, what is much more unconquerable, the private interests of many individuals irresistibly oppose it."

What Adam Smith thought in his day impracticable and Utopian, has happily been accomplished; but the old prejudices still prevail amongst many from whom we might have hoped better things. It is not uncommon to read in our newspapers and periodicals lamentations on the falling off of our export trade and the increase of our imports, with prognostications of destruction to our manufactures and ruin to the country. These notions are founded upon the old principle of the balance of trade, viz., that a country which imports more than she exports will be drained of specie, and eventually deprived of the means of subsistence.

It is not so long since a respected member of Parliament, closely connected with Liverpool, wrote in the *Times* a series of letters of the most alarming character, calling attention to the serious increase in our imports and the diminution of our exports, and drawing the inference that, so far as trade and commerce is concerned, the sun of England is, as it has so often done before, about to set. I think a little consideration will go far to neutralise these dismal vaticinations, and to shew that England has nothing to fear, and everything to hope.

Whatever inferences may be drawn, the facts are sufficiently startling.

In the year 1860 the imports into the United Kingdom of merchandise, exclusive of bullion and specie, were £210,530,873; the exports amounted to £164,521,351, leaving a balance against us of £46,009,522. In 1877, the last year for which the returns are made up, the imports amounted to £394,419,682, and the exports to £252,346,020, leaving a balance of £142,073,662, being an increase in seventeen years of the balance against us of nearly one hundred millions. See, say the advocates of restriction, what your free-trade has brought us to; this one hundred and forty-two millions of balance represents so much abstracted from our own industrial population, and given to the foreigner. Well may trade be bad and our artisans out of work, and depression pervade our manufacturing districts. A gloomy picture enough, if it were true, and calculated to excite serious apprehension. Let us, however, endeavour to analyse the facts, and examine the conclusions to which they point, when carefully considered.

First, how far are these returns accurate and reliable? Whatever may be the case with the imports, the returns of the exports, principally *ad valorem*, are notoriously incorrect, being in many cases given at random, and in others with intention to deceive. There is no doubt the returns are very much below the reality. Again, the returns of the exports, whatever they may be worth, are given as the value at the shipping port, to which the freight, insurance, and charges have to be added before the goods reach their destination. The imports, on the other hand, are valued on their discharge, with these charges already added. The percentage to be added in the one case, or deducted in the other, will make a considerable difference in the proportions. Further, it seems to be taken for granted by those who draw such

gloomy conclusions, that the test of national commercial prosperity is the excess of exports over imports. Why should this be so? One would naturally think that if I make a venture in sending goods abroad, and receive more in return than I sent, the balance is in my favour. Thus M. Say remarks:—" Tout commerçant fait un gain lorsque la valeur des retours qu'il reçoit surpasse la valeur des envois qu'il a faits. Si en retour d'un envoi de 100,000 francs que j'ai fait, je reçois une valeur de 90,000 francs, fût il en or, il est constant, il est avoué que je suis en perte de 10,000 francs; si je reçois des marchandises pour une valeur de 110,000 francs, je gagne 10,000 francs, quand même parmi ces marchandises il n'y aurait pas une once de metal precieux. Il n' est si mince négociant qui ne soit convaincu de la vérité de cette assertion; elle se prouve par son seul énoncé. Ce qui est vrai d' un négociant est vrai de deux, de cent, de tous. Ceux qui gagnent reçoivent des retours supérieurs en valeur à leurs envois; et comme on ne peut pas supposer que la majeure partie des négociants d'une nation fasse habituellement un commerce qui leur donnerait de la perte, on doit admettre que la valeur des importations est en tout pays superieure à la valeur des exportations. Les importations surpassent même d'autant plus les exportations, que le commerce est plus lucratif." *

We see, then, that, other things being equal, an excess of imports is a sign rather of prosperity than of decadence. But it will be said other things are not equal; the balance of trade being against us, gold must flow out of the country, and so impoverish the nation. If the fact were so, still the inference might be doubted; but what is the real state of the case? In 1877, with the so-called balance of trade against us of one hundred and forty-two millions, we exported twenty millions of specie, and imported thirty-seven millions, being

* *Economie Politique*, i., 562.

a balance in our favour of seventeen millions of additional specie in our coffers. But it may again be rejoined, assuming all you say about the benefits of such large importations, are not our manufacturers seriously injured by this influx of foreign goods competing and thrusting out our own? A glance at the nature of the returns will do much to reassure us on this point. Out of the three hundred and ninety-four millions of our imports during the year 1877, no less than one hundred and fifty-eight millions and a half consisted of food, which, in this single item, exceeds by sixteen millions and a half the total excess of imports over exports. This is a trade which has almost entirely grown up within the last few years, since the abolition of restrictive laws. In 1840, before the abolition of these laws, the importations of food, including tea, sugar, and groceries, only amounted to twenty-seven millions and a half. During this period the population has increased twenty-seven per cent., whilst the foreign food supplies have increased nearly five-fold. The general increase in our imports has been either in food or in raw produce the materials for manufacture, the increase in manufactured goods having been comparatively trifling.

According to the old theory of the balance of trade, this excess of imports should have led to a drain of the precious metals from this country. But what are the facts? The exchanges are in our favour in nearly every country in the world, which indicates that there is more due from other countries to England than there is due by her. This, upon reflection, is easily accounted for. The enormous amount of English capital invested in foreign stocks, railways, and other enterprises, has left a large amount of indebtedness to this country, the interest of which has to be remitted in some form or other. Whether it is by bills on London, by remittances in specie, or by importations of produce, it comes

eventually to the same thing, enabling us to command the markets and to accumulate the riches of the world.

But it may again be asked, if all this be so, and the commercial position of England is still maintained, how are we to account for the long and severe depression which has weighed down all branches of trade and manufactures, not merely at home, but throughout the commercial world? Many causes have combined to produce this result, not the least the desolating effects of the wars which have ravaged Europe with little intermission for a number of years, but the main cause has been the temporary suspension of purchasing power. In ordinary times the expenditure of capital on enterprises expected to be profitable, and the returns therefrom, proceed quietly in a certain ratio, but if, from any cause, vast schemes are entered into, involving an enormous outlay, the results of which are either disastrous, or the benefits of which have to be waited for, and if such expenditure, after producing an inflated and specious prosperity, suddenly ceases, it is clear that a corresponding depression must take place, and considerable time must elapse, before the equilibrium is restored. The factitious prosperity which raised all markets so high a few years ago, was mainly caused by the large loans of money invested in foreign enterprises, which caused an unprecedented demand for our manufactures for a time. This spasmodic outlay could not be continued, and when it terminated the demand came to a close, added to which many of the enterprises were not remunerative, or at least not immediately so, and were unable to pay any interest or dividends. There was therefore a double loss. The demand had been created by the outlay of our own capital, which was abstracted from its normal course, and the returns not forthcoming, to that extent crippled the resources of the country.*

* See an excellent article on Commercial Depression, by Professor Bonamy Price, in the *Contemporary Review*, for May, 1879.

Time must elapse before the lost ground can be recovered, and the purchasing power restored. In the meantime there is no reason whatever for despondency. The wants of mankind are the same as ever. The means of supplying them were never so thorough and complete. The necessaries of life, compared with their value in labour, were never before so cheap. The capital of England is prepared for any enterprise which will contribute to the comfort and progress of mankind. The true balance of trade will be found in the free intercourse of nations, and in their friendly rivalry in the mutual supply of each others wants.

ON THE SIMPLEST POSSIBLE EXPERIMENT IN PHYSICAL SCIENCE; AN ELEMENTARY STUDY IN PHILOSOPHY WITHOUT ASSUMPTIONS.

By THOMAS P. KIRKMAN, M.A., F.R.S.

PART I.

I TAKE my text from John Stuart Mill's chapter of his logic "On the Law of Universal Causation," in the seventh section of which he says: "The rotation of the earth is entitled to be ranked as a primeval cause. It is, however, only the origin of the rotation which is mysterious to us: once begun, its continuance is accounted for."

I am far from the wish to figure as the antagonist of Mr. Mill. I address a school of philosophers who, while they differ on many questions, seem to be agreed in accepting as scientifically true this proposition of my text: The continuance of the rotation of the earth is accounted for.

I represent an opposite school of philosophers, who affirm that the proposition is the reverse of scientifically true. They maintain that this rotation, although given by observation of the past, is not accounted for by merely dynamical demonstrations, either for the past or for the future.

The latter school declares with me its firm *belief* in the future continuance of this rotation. The former asserts its *demonstrated knowledge* of that continuance. Every one can see the bearing which this dispute about a given fact has upon questions of human interest ineffably higher than the science of motion, or any other science.

My object is to review the arguments on both sides, with all the brevity in my power, consistent with complete examination.

The very title of this chapter of Mill places us in the court of the higher philosophy. It is sufficient for my purpose to define this as the court to which are to be referred all scientific questions, and all attempts to selve such questions, touching the *cause* or the *future* of any finite existence or fact, vital or not vital. Of other questions belonging to this court I have no occasion here to speak.

In pure mathematics, which justly glories in its demonstrations, there is no future. All space and all number given to human thought are alike given now. Dynamics, the only one of the departments called sciences which professes to account in the sense of my text from this Logic, *i.e.*, with demonstration, for any event in time in the external cosmos, connects itself with the higher philosophy by its first propositions, which some call laws, others axioms, while others give them both names. For example, Newton heads his immortal treatise with 'Axioms or Laws of Motion.' As to what they call Evolution, that soars far above demonstration: nobody pretends that it offers anything like demonstration with a single one either of its dogmas or of its dreams.

It is not necessary for me to criticise the expression of Mill's notions of the dynamical axioms, which occur next after my text, and elsewhere in his writings.

If any man brings into the court of the higher philosophy any proposition from the lower philosophical departments, he is required to bring its demonstration along with it. The grand words *must be* without *must follow*, and *self-evident*, are not admitted there. Nothing is self-evident there except that evidence which never has to be called, the immediate witness of consciousness alike in every thinker present. If a man attempts to palm off on this higher court, as a demonstrated truth of his science, something which he only believes firmly, as others do, or which he is resolutely determined shall be so, he is put down and exposed as a professor of

sham science. Do you ask why, because it deals with the future and the cause, this should be called the court of the higher philosophy? The reason why is closer to you than any argument of mine can be. Ask yourself, What is the cause of me the thinker? What is to be the future, whether remote or near, of me the thinker? You see and feel the grandeur of the questions and of the relations which hang on them, and how far beneath them are all the questions that science can both ask and answer; for they are no questions about any phenomenon that is given to the handling of science, either of the present or of the past.

The assertion before us is that the future continuance of the earth's rotation is accounted for; that is, in this treatise of logic and philosophy, is now demonstrated. The question, then, that I place before you is, Can we really demonstrate, say for a week, the future continuance of this rotation? It is no question about motion or anything else in the abstract, as they say, or in general; but only about the future continuance of one given concrete fact. Whoever rises to answer the question may bring laws and axioms at pleasure, on the stern condition that he logically proves the truth of every proposition.

We shall have forced on us a discussion on different statements of the first law or axiom of motion. I will now read my text again, with the rest of the sentence.

"The rotation of the earth is entitled to be ranked as a primeval cause. It is, however, only the origin of the rotation which is mysterious to us: once begun, its continuance is accounted for by the first law of motion (that of the permanence of rectilinear motion once impressed) combined with the gravitation of the parts of the earth towards one another."

I read this in order to remark, that a special pleader may find it useful to deny that Mill nakedly affirms that the future

continuance of the rotation is now demonstrated, saying, that he means only that it is demonstrable, if you grant that the first law is what Mill evidently held it to be, a demonstrated theorem. Thus I might be charged with a suppression of qualifying words.

His clause is, without any if, or any comma in the clause, "its continuance is accounted for by the first law of motion." The special pleader, if he ever shows himself, will be one of unusual courage.

There is serious discord in the statements of this first axiom by dynamical writers; but no harm arises from the discord, so long as it introduces reasoning purely mathematical. I do not presume as a mere mathematician to criticise the form in which the axiom is presented in any treatise of mechanics. All forms are accurate enough where they stand, and the processes and results built on them are mathematically correct.

Since the answer to every question asked in terrestrial or celestial dynamics is always expressible as a number, every alleged defect of logic or of rhetoric in the opening axioms is eliminated by the crucible of unrelenting arithmetic through which they finally pass.

Let me repeat distinctly, in order to prevent the calumny that I am presuming to throw doubt on the grand foundation stone of dynamical science, the first axiom of motion, that I accept that axiom, as a mathematician, in every form in every dynamical manual; I accept it within the limits of all human observation and computation: first, because I believe it firmly for empirical reasons, although I cannot demonstrate it; and secondly, because I see that if it is not demanded and granted by all, we cannot possibly take one step in the science of motion.

Will be so, I firmly believe, say I, of this continuance of rotation; but I cannot prove it scientifically; yet I can give

noble reasons for my belief, which lead to far grander questions. *Must* be so, because we know, and can prove it must be so, say my opponents: there is no room at all for mere believing in the matter, nor for your reasons of mere belief; so that your grander questions which come out of that are all moonshine and nonsense. Wherefore leave all that and listen to our science with deep attention and trust immovable.

That is exactly the attitude of the two schools: it is hardly yet a pretty quarrel as it stands. There is hope for honest debate; and it might soon be settled, if one discreet party had not such a horror of coming to close quarters.

There is nothing to prevent the dynamical mathematician, as he rattles away about powers, capacities, efforts, and potential energies, from decorating his page with incongruous tropes and figures, with absurd personifications, anthropomorphisms, or zoomorphisms *ad libitum;* because he can never get them into his equations.

In order to show more clearly my meaning, I read what caught my eye in opening at random a French analytical manual of the highest class, the *Traité de Mécanique de Francœur*, at page 216; which literally rendered is—"When a body is moving itself in a fluid, it is obliged to employ part of the force with which the motive power has made it alive, in displacing the molecules of the fluid, in making for itself a passage among them, and in moving itself along. This effort, used by a body which is moving itself in a fluid, depends upon the velocity which makes it alive."

This sprightly rhetoric is harmless in mechanics. But if it were brought forward in a debate on this immortal title of Mill's chapter, "On the Law of Universal Causation," it would have to be shorn of its tropes and anthropomorphisms. For in the court of the higher philosophy there is no final crucible of arithmetic to consume the nonsense.

When two schools differ, the wisest thing that they can do is to meet at the point up to which they are agreed, and at which their views first diverge, and there to debate the matter thoroughly, discarding tropes and tricks on both sides. I believe that this uniform motion under the first law is the first point of divergence in teaching of the two schools of materialist negation and spiritualist affirmation, concerning the cosmos of which we are a part. Where else can we look for such a point? What fact can we discuss which does not involve motion? What motion can we conceive so simple as that defined under the first law?

No time is too long, no caution is too minute, no pains nor patience too great, to be heartily employed by us all at this one point, until every hindrance to brotherly consent has been removed. Permit me to state for the benefit of younger thinkers what is required by sound logic as the true procedure of reasoned debate, which is to be better than rambling and wrangling.

First, there should be a *datum* plainly laid down, clear of sophisms, tropes, and ambiguities, and accepted on all hands as a confessed certainty within defined limits, limits exactly stated, whether of time, place, persons, agencies, or conditions; and in the datum should be no lurking assumption of the thing to be proved.

Secondly, there should be a *question* proposed in terms equally precise, or else a proposition enuntiated as the conclusion which is to be proved, quite free from tropes, hidden assumptions of what is not given, and those most disgraceful banes of philosophy, abstracts undefined.

Thirdly, there should be a reasoned *answer* affirming or negativing the proposition under discussion, or else showing that a rigorously scientific conclusion about the matter is beyond the competence of human thought.

It may easily be, that a valid demonstration of his own

incompetence may be to the true philosopher, in the presence of the wondrous facts of force and life, a thousand times more precious, fruitful, and inspiring than all the victories of his science.

Suppose, now, that a philosopher were undertaking to demonstrate to us the future continuance of the earth's rotation, so long as no external force shall interfere with it. He would have to lay down his *datum*. He might say—given the earth in uniform rotation under the action of no opposing force: required to demonstrate the continuance of the rotation. Would that do?

We all grant the facts; but we want a limit. We should ask—Given how long?—given rotating as long as you please? Then your demonstration will be an easy one.

He would have to fix his limit. He might say—Given the earth uniformly rotating till noon to-morrow: to demonstrate the continuance of the rotation after that instant. Would that do?

I should beg to know exactly the fact given at noon to-morrow. I should ask—Rotating at noon to-morrow for how long? For as long as you please? We should all soon see that the only datum which does not contain a lurking assumption of the continuance to be proved should be this:—Given the continuous uniform rotation of the earth up to the instant of noon to-morrow, nothing at all being given by affirmation or denial as to the continuance or change or cessation of the rotation, for any time after that instant of noon.

There are doubtless philosophers ready to undertake the rigorous demonstration of this future continuance upon the datum thus limited. Others, more acute, would politely decline it; and some of them might even put on the air of injured innocence, protesting against being dragged into the metaphysics of abstract motion; while in truth we are hand-

ling nothing abstract, but simply one hard and familiar fact, the rotation of our planet; and while instead of metaphysics we are considering a plain affirmation without proof, of their prophet Mill about that fact, and inquiring, Is this true?

It is almost impossible to get an answer out of the thinkers whom I combat, concerning the dogmatic beginnings of their teaching. They invariably remark—"Oh, that's metaphysics," and walk away. The unproved negations and assertions and the exposed sophisms of a writer like Mill are not metaphysics, but logic and science. It is only when you bother and ask—Is this true? What's the sense and reason of that? —it is then that the metaphysics always begin.

Before I endeavour, as I wish to do with all my force, to set before you what a demonstrator of Mill's school would say, it would be very useful to exchange our datum of uniform motion of rotation for one of uniform rectilinear motion; this will not increase but rather diminish the difficulty of my opponent's reasoning, while it will aid our conception of the question in debate. The earth is too vast a body; and it is very difficult for the non-mathematician to understand how the first law of motion can supply, as Mr. Mill affirms that it does, an argument for the continuance of rotation; because most thinkers about this subject conceive that the persistence of uniform rectilinear motion only is that spoken of in the first law, and not that of the uniform motion of a particle in a direction ever-changing in a circle. Mr. Mill was correct in affirming the application of the first law to both kinds of uniform motion, rotatory and rectilinear.

How are we to find this datum of a body in uniform rectilinear motion, undisturbed by external force? There is no such body in this cosmos, if science tells the truth. Such a motion of any body, from sun to atom, for the length of one inch, is imaginary and impossible. To say nothing of countless other forces at work of which our scientific know-

ledge is vague and all unformulated, gravitation, the only force of which the law is known, prevents it; for according to science every body in the universe is continually either accelerating or retarding every other moving body which it does not touch.

We must content ourselves with an approximate datum, as there is no really given motion of a body perceptible by human sense, which is undisturbed by friction or by other masses, except the rotations of the celestial bodies.

I can easily shew that approximate data are valid in science for the most rigorous trains of reasoning. They are always occurring in pure mathematics. What are the roots of $x^2 = 2$? The square root of 2, taken with either sign, is the value of x. But this square root cannot be correctly assigned. That does not interfere with rigorous reasoning about such a value in the theory of equations, or in that of numbers. You can begin and carry on your work correctly to extract the square root of 2; but you can never finish it. The decimal has no last figure, and never comes to a repeating period. No angel in heaven can write down that decimal number. He might cover the firmament with microscopic lines of figures, at every decimal place one figure and one only correct; he might, in the same way, cover with his continued work millions more of firmaments, and still no end and no repeating period. That does not diminish the accuracy of mathematical reasonings in which the square root of 2 is a datum. The reason of this is, that we can continue our approximations to the true value without limit, coming nearer and nearer, till the defect is millions of times smaller than the error which any critic can lay to our charge.

Let us begin our approximation to a datum of uniform rectilinear motion, under the action of no external force. For this I have to perform the simplest possible experiment in physics. This marble is at rest on the table. I push it

with my finger; it moves so long as I press it, with accelerated speed if my pressure is greater than the resistance of friction. It moves when I no longer push it, with retarded velocity. Our approximation starts from just what happens, when I have ceased to push it. I am not making it move when I am not touching it. It is then persevering, as Newton, for profoundly wise reasons, phrases it; and it would have been persevering to this moment after my first push, if the friction against which it fought to the last had not conquered it. The experiment and approximation would be more successful on a table of ice. Give me a path a mile long, to human perception perfectly level, perfectly smooth, and therefore perfectly slippery, and remove to the utmost of human power the resistance of the air over it; then I will engage that that marble, after such a push as I gave it, shall persevere, not rolling but sliding, for the whole mile, with velocity unchanged—at least to human observation unchanged.

That would be a very near approximation to the datum sought. Such a movement would be nearly as true a case of motion under the first law as is the earth's rotation. Gravitation to the earth is eliminated by the reaction of the level path, and measurable friction is eliminated.

There remains only the disturbance of the marble's motion by the attraction of all other bodies in the cosmos. If you grant that these may exactly counteract each other at every point of the marble's path, you have before you almost a perfect case of such undisturbed and uniform motion, and of the simplest experiment in physics.

You can affirm without absurdity that a sufficient application of human skill and labour can make a level path a mile long, covered with glass, exhausted of air, and then hermetically sealed; the level being so true, the slippery smoothness so complete on a polished material dense

enough, and the exhaustion so extreme, that a small sledge of iron within, at rest at one end, being set in motion by the approach of a magnet, and the magnet being withdrawn, the sledge would slide along the whole mile without any sensible change in its velocity. If the sledge were armed before and behind with cushions of elasticity perfect to human sense, and if two similar cushions terminated the tube within, the sledge, after collision with one cushion, would have its velocity first destroyed, and then by the recoil exactly restored in the contrary direction, and it would thus travel from cushion to cushion for a certain number of times, at a slowly diminishing speed, until the feeble friction, which we must believe to remain in spite of the highest polishing of man, quite destroyed its velocity.

If the conditions of level, of smoothness, of exhaustion, and of elasticity could be made really perfect, then I believe that the motion of the body backwards and forwards in that tube would go on, I will not say as long as the rotation of this planet, but much longer than we could stay in the planet to watch it.

Dynamical mathematicians have often brilliant imaginations and are famous hands at fiction. They make no scruple of saying—Suppose a body set in motion in a right line with a certain direction and velocity, and then left to itself, under the action of no external force. They have no right either in science or in sport to propose an impossible supposition like that.

But if this thing is possible, I have a right to ask you to suppose that our engineers in their philosophic ardour have constructed for us, regardless of cost, such an approximation as I have described. When they have done it for a mile, they will, with the help of the chemist, discover a metal, or a lacquer, or glaze, so hard and capable of a polish so slippery, that they will do it for ten, twenty, thirty miles, till

at last, when the crowning approximation to a frictionless path is revealed to science, it is announced that an exhausted tube of one hundred miles in a direct line has been solidly laid along an English plain out of the reach of vibration; and we are all invited to see a little sledge of iron set in motion by a magnet, carrying its perfectly elastic cushions, and sent on its first trip of a hundred miles, from which, after thumping the cushion at the other end, it is confidently expected to return to thump the cushion at the starting point, and to repeat the journey with almost unchanged velocity again and again, as long perhaps as any of us live.

Let this be our datum: it may look a little incredible; but it is not so outrageously wild as the data to which the mathematical professors help themselves every day without rebuke.

We are all glad of the invitation. We know of the success of previous experiments; and though we feel a little sceptical excitement, we have no doubt that if only the friction has been made to disappear, as the engineers affirm, this too will succeed; for it is no miracle. The motion from cushion to cushion is just the simplest possible case of motion and experiment in physical science, the uniform motion undisturbed which is described in most of the manuals under the first law. It is much easier for us to grasp than the rotation of a world.

I say to myself as I join the party, If this is a success, that little silent sledge may prove to be a preacher to the philosophers of this generation of more eloquence, power, and real usefulness than all the cushion-thumpers in Europe.

We are, if you please, here in the town A, in which the departure of the sledge took place at three o'clock this afternoon. We saw its first motion towards the magnet, and we

watched its uniform movement at one foot in a second with our glasses as long as it was in sight. We have had a good dinner, and here we are discussing the higher philosophy of this interesting fact.

I am permitted to ask a question preceded by a datum accurately stated.

I say, Given that sledge in uniform motion with the velocity *one*, that is, at the rate of one foot a second, from three o'clock this afternoon till the instant of noon to-morrow, nothing at all being given, yes or no, about the continuance, the change or the cessation of its motion after that instant, except that the body shall be neither accelerated nor retarded by any external force, that is, by the action or influence of other bodies or body. That is the datum, if you all accept it as so given. I say if you accept it; for the fact before us is only an approximation to the datum laid down. I presume that we agree to leave out of sight the disturbance which in reality tells on that sledge when I move my arm, and the immeasurably small friction which will in time retard its motion.

The question is not what we believe (for we all believe the same thing), but what can we rigorously demonstrate about what will become of the sledge after the instant of noon to-morrow? Mere briefly the question is, What will become of the sledge after noon to-morrow?

Here, sir, you have the right to ask me, in order that your time may not be needlessly wasted, whether I have a scientific answer to give to my question, or anything like one.

I reply—I have an answer which is not a direct demonstration, by reason that it contains an *if;* but I am sure that it is scientifically accurate. I hope it will not be called a truism, because, if it be accepted as the only scientific answer, it leads to another question of greater dignity,

namely, to this—What is the cause of this uniform motion? My answer is—If the moving power which is acting in every particle of that sledge, whereby it uniformly moves in a straight line onward, shall continue its action unchanged after noon to-morrow, the sledge will continue to move after noon in the same direction and with the same velocity as before noon. But if that moving power shall suspend or change its action at noon to-morrow, the sledge will stand still or move with altered motion. Of course that moving power is not what is called an external force, due to the action of other bodies.

I then sit down to hear the discussion. Hereupon Dr. Mustbeso rises. Allow me for a moment to be the learned doctor.

I have two easy tasks to accomplish. The first is to shew that Mr. Kirkman's answer to the question is utterly erroneous. The second is to give the correct scientific answer, and to prove its correctness.

In the first place, then, Mr. Kirkman's notion of a moving power, acting in every particle, to which the uniform motion of that sledge, or of a body under no force, is due, is one unheard of in the whole world of science. I defy him to name a mathematician who ever even hinted at such a moving power.

The body set before us in the datum is described in hundreds of dynamical manuals as a body moving under no forces, that is, under no moving power of any kind whatever; for what is a moving power, if it is not a force?

Mr. Kirkman is imagining, as I suppose, a sort of internal immaterial power or force at work in the body, different from the mutual action of its internal molecules, of which action we have determined as yet nothing, except that it is the same whether the body be at rest or in motion, and can have no resultant in any direction. Who is not aware

that universal science knows nothing, permits nothing, and is determined to listen to nothing, of such superstitious and exploded nonsense?

The fundamental property of matter is its *inertia*, that is, its inability to change its state. When a body is in a state of rest undisturbed by any external force, it remains at rest; and for what reason? Because of its inertia, because it cannot change its state. In the same way, when a body is in a uniform state of motion, undisturbed by any external force, it remains in its state of uniform motion; and for what reason? Simply by reason of its inertia, that is, of its utter incapability of altering its state. When a body is in a state of rest, Mr. Kirkman would hardly display his science by asking what is the rest-keeping power, or the place-holding power, which prevents this body which I see at rest, and undisturbed by force, from quitting its state of rest, and which keeps it in that unchanging state. Well, it is just as wise a thing, when a body is in a state of uniform motion under the action of no force, to ponder and wonder what is the moving power which keeps that body in an unchanging state of motion. The answer in both cases to the question, Why? is the same, the *inertia* of the matter of the body, whereby it cannot change its state, until compelled by force.

If either the direction or the velocity of that sledge were changed, there would be an event before us for which science would ask the reason; and that reason would surely be a material force, *i.e.*, the action of some other body. But so long as the sledge remains in that unaltered state of motion, there is no event. Why invoke a motive power? There is nothing for it to do. There is absolutely nothing before us to be accounted for by acting force or power of any kind. Thus we all see the nonsense of Mr. Kirkman's answer.

Now for my second easy task, which is to shew and to prove that the sledge will continue after noon to-morrow to move exactly as it moved before noon. Perhaps the shortest way to do this is to read from this admirable book, Professor Young's *Course of Elementary Mathematics*, his brief account of the first law of motion. The simple perusal of this paragraph is of itself a completion of both my tasks. He says in the first page of his Dynamics, speaking of the point called the centre of gravity of a body: "If the forces cease to act the instant the point starts into motion, the point must not only commence but continue to move; that is, its path must be a straight line, and in the absence of all interference, its onward motion must be uniform. These truths must be admitted as self-evident. They are usually ennunciated in the form of an axiom, in the following terms, and constitute what is called the First Law of Motion.

"Mere matter if at rest and unacted upon by any external force, or only by forces of which the resultant is nothing, must remain at rest.

"If it be in progressive motion, and unacted on by any external force, it must continue in motion, the motion must be uniform, and the centre of gravity must describe a straight line. And this is only affirming that inanimate matter is *incapable of itself* of altering the state into which it is put by any external cause, whether that be a state of rest or a state of motion; this incapability is called the *inertia* of matter."

These truths, says Professor Young, must be admitted as self-evident, and universal science says the same thing. What I have read sufficiently proves the affirmation of Mr. Mill about the continuance of the rotation of the earth with velocity unchanged, that it is accounted for, and proves also the future continuance of the motion of the sledge, beyond any point or instant of its motion as defined, with both

direction and velocity unchanged. Mr. Kirkman wishes to have a metaphysical wrangle with us about the demonstration of self-evident truths. The world of science is not quite young enough for that.

But I will walk up to Mr. Kirkman's limit, and there demonstrate the continuance of the motion, at the same time reading a few sentences from the most recent, and for that reason probably the most correct, treatise on Dynamics, that of the late Professor Clifford, published by Macmillan and Co., 1878.

Let O be the starting point of the sledge, and P the given position of its centre of gravity at the instant of noon to-morrow, and let T be that instant.

I say that, in Mr. Kirkman's limited datum of the line O P, described with the uniform velocity one, the centre of gravity at the point P is given to us as having at the instant T the velocity *one;* and in saying this as a mathematician I am not straining the limit laid down either of space or of time. I am thinking and speaking only of the one instant T and the one point P, when I affirm that we have given to us the velocity *one* there and then. Hear Professor Clifford, at page 48 of his chapter on uniform velocity:—"To say how fast a body is going is to make a statement about its state of motion at any instant T, and not about its change of position in any length of time. The velocity of a moving body is an instantaneous property of it." Again, in page 49, "This rate (that is this velocity *one*) is a property of the motion which belongs to it at a single instant T." This velocity *one* is therefore the given instantaneous property of the body at the instant T and at the point P.

At that instant the body must, firstly, either come to rest, having the velocity nothing at P, or, secondly, it must change its velocity at P to something more or less than *one;*

or, thirdly, it must go on with direction and velocity unaltered. Now to say that, at the instant T and the point P the centre of gravity shall have both the velocity one and the velocity nothing, is a contradiction; and no less absurd is it to say that, at that same point and instant, that centre shall have a velocity which is exactly one, and which is either more or less than one. It is, therefore, demonstrated that at noon to-morrow the sledge will be moving, and will continue to move onwards in the same direction and with velocity unaltered, and the question is directly answered.

But I am really ashamed, Sir, to be occupying your attention with such a question, which, I must beg leave to say, is the most frivolous that was ever proposed to a philosophical society.

Here the demonstrator sits down with applause, in which I join, saying to myself, The stout little doctor has put that together well. And I hope that both sides, until somebody has done it better (for, of course, that gentleman will have the courage to try), will give him credit for constructing the most valid sophism possible with his materials.

After some discussion, I am permitted to reply both to the charge of error in my own hypothetical answer, and to the doctor's direct demonstration. To the latter I address myself in the first place thus:

Leaving out Professor Clifford's matter, every word of the demonstration after the first is both correct and quite superfluous, if only that first be true. That first word was, "I say that in Mr. Kirkman's limited datum the centre of gravity of the sledge is given to us at the instant T and at the point P, as having the velocity *one*." Is that true? If it is, then the sledge is given to us in our datum in continued future motion at the instant of noon to-morrow, and there is no need of a single word more. For every mathematician knows that the velocity of a particle at a point P and

instant T is never either sought or found, nor spoken of, unless the particle is first given to be in motion after the instant T, over a positive increment of time, which is only made infinitesimally small when the velocity is not uniform.

But our *datum* at P is expressly defined to be a body neither given to be in motion nor given to be at rest after the instant T, nor given either to have or not to have any increment whatever either of time or space to move over. And we framed that datum so, because we saw that by no other terms could possibly be excluded the lurking assumption of what is required to be proved.

The doctor armed himself with a paradox of Professor Clifford, about what he calls instantaneous velocity—given by one mathematical point and one indivisible instant of time, a velocity over no space at all and during no time at all. As my object is neither to fight with a Mill nor with a Clifford, but to do something better, to help young men to think closely for themselves, I shall not detain you about that paradox. If you refer to the page in Clifford's Dynamics, which you will find in your noble public library, you will see that he is speaking of a point and an instant on both sides of which the moving body is given to be in motion. The point P is no such point, and the time T is no such instant; so that if Clifford's teaching about instantaneous velocity were not nonsense, but sense, it is not applicable to our datum at the point P and the time T.

That paradox is a needless yet not a purposeless over-statement about a familiar mathematical approximation; needless and harmless in dynamics, because it neither helps nor hinders either in the asking or answering any possible dynamical question. But not purposeless; for like too many of Professor Clifford's statements it appears to have a definite polemical aim, although not a mathematical. I never

saw so thrust forward in any other dynamical treatise that paradoxical overstatement.

Dr. Mustbeso and I know something. We know who laid their heads together, as they said, We want this link, which we must get fastened into the manuals. It can do neither harm nor good in our mathematics and ideal kinematic; but it may help us elsewhere to shut up those parsons who go about laughing at our logic.

I beg you all to notice that this unreasoned talk of Dr. Mustbeso and Professor Clifford about instantaneous velocity, though rather deep, is not at all metaphysics, but only science. If any of you should ask them to explain or to prove it, that would be metaphysics.

So much for the direct demonstration. Next I review the doctor's proof that I was talking mere nonsense when I affirmed this as a certainty of science:—"If the moving power which is acting in every particle of that sledge, whereby it moves uniformly in a straight line, shall continue its action unchanged after noon to-morrow, the sledge will continue its motion after that instant without change of direction or velocity. But if that moving power shall suspend or change its action at noon to-morrow, the sledge will stand still, or move with altered motion."

To expose my error the Doctor read, from a treatise really most admirable for its teaching power, the writer's statement of the first law of motion, as it is usually laid down.

I have already said that I do not presume to criticise such a statement prefixed to merely mathematical reasoning. It is not Professor John Radford Young, but Dr. Mustbeso, who brings it forward in this court of the higher philosophy. Am I to understand that the Doctor presents that definition of what they call *inertia* as his own? "Assuredly," he answers, "I agree exactly with Professor Young that the

inertia of inanimate matter is its incapability of itself to change its state." Ah! Doctor, say I, I have another definition which I like better. I maintain that the *inertia* of inanimate matter is its incapability of itself to play the fiddle. Pray, Doctor Mustbeso, did anybody ever say or think that inanimate matter was able of itself to change its state? "Certainly not," he replies: "I was remarking that its *inertia* is its incapability to change its state." Then retorting, he demands, "Pray, Mr. Kirkman, did anybody ever say or think that inanimate matter was able to play the fiddle?" Certainly not, I reply; I was remarking that its *inertia* is its incapability to play the fiddle. And I maintain that those two remarks are equally profound and philosophical, and equally *àpropos* of everything.

You heard the Doctor read that passage, a storm of must-be's, followed by one glimmer of attempted light: the Doctor exploded a bomb-shell of must-be's; and nobody killed! Then it may be safe for me to read again the whole passage. The importance of the topic makes it well worth the while.

"If under the operation of forces thus conceived to be applied to the centre of gravity, progressive motion actually takes place, the movement of that centre must therefore commence in the direction of the resultant of those forces, and being only a point, its path must be a line. If the forces ceased to act the instant this point starts into motion, it must not only commence, but continue to move in the direction of the resultant; that is, its path must be a straight line, so long at least as no external obstacle or influence interferes with its onward progress, and in the absence of all such interference its onward motion must be uniform. These truths must be admitted as self-evident: they are usually enunciated in the form of an axiom in the following terms, and constitute what is called

The first law of motion.—Mere matter, if at rest and unacted upon by any external force, must remain at rest. If it be in progressive motion and unacted upon by any external force, it must continue in motion, the motion must be uniform, and the centre of gravity must describe a straight line."

That is pretty strong, and plenty of it:—

'Drink deep, or taste not the Pierian spring.'

You ask for a ha'porth of bread to your drink; here it is:—

"This is only affirming that inanimate matter is incapable, *of itself*, of altering the state into which it is put by any external cause, whether that be a state of rest or a state of motion; this incapability is called the *inertia* of matter."

So this is only affirming that inanimate matter is really dead matter, not one bit alive. That is all your allowance of bread. Falstaff himself would grumble. One crumb of a truism to all that sack!

Why should inanimate incapability be called *inertia?* In this court every word, whether English or Latin, stands for its own meaning, and for nothing else. In the huge Latin Lexicon of Facciolati, the only meanings of *inertia* are laziness or sluggishness, want of art and skill, and inaction for lack of something to do. In the Latin examples given under the word, *inertia* is never either death or helplessness, and is never attributed to the incapable, but always to the living and conscious. An incapable inertia is a contradiction in terms; an inanimate inertia is a worse contradiction. Violent tropes being excluded, the phrases can serve no purpose of sincere science. They are ridiculous sophisms when given as reasons for rest, and still more ridiculous, when given as reasons for motion.

Why does a paving-stone on a heap remain at rest? This philosophy solemnly answers—Because of its *inertia.*

Not because it is a dead and purely passive thing, but because of its utter laziness! This approaches to the anthropomorphism of the savage. One thinks of the Fiji or Fantee philosopher, peeping from behind his tree at some grotesque and motionless mass, which he has adopted for his fetish: "Him not dead, him not sleep; him only doing nothing and lazy just now; but when him jump up—Oh!" Next look at the *inertia* of matter in motion. Why did that mountain-range at our equator, having been once set in motion of rotation at a thousand miles an hour, why did it and why does it continue to move at that amazing rate for countless milleniums? The solemn voice again answers—Because of that same *inertia;* because the mountains are incurably lazy. That's the reason—that is the sufficient reason, say our philosophers—and there is no other in the universe. I think that the sluggishness and laziness of those mountains is a bad reason for their persevering motion.

Call me captious as you please. No man can be too captious about terms, grand Latin words, at the very first step of cosmic philosophy. It is my rule to shoot down every sophism I detect before it is a yard from my opponent's chin; and I say, gentlemen, more than one can play at that. So keep your pieces at full cock, and shoot down mine.

I am not presuming to criticise the use made by dynamists of this term *inertia,* as a convenient trope, or useful label or bracket in terminology. How it first came into use I know not. If I have shewn that it is employed in the questions of the higher philosophy for the purpose of sophism, I am justified in these remarks on it. The sophisms which it serves are fundamental to sham science; *to confound the distinction of active and passive,* and *to abolish the eternal relation of change to cause.* We dismiss this *inertia* without any stain upon its mathematical character, either as a label or a bracket.

If any man were mad enough to affirm that inanimate matter is capable of itself of changing its state, he would utter a falsehood along with an anthropomorphism. And whoso in a hall of science condescends to deny the assertion utters a worthless truism disfigured by a conceded anthropomorphism, in the words *self* and *capable*.

Inanimate matter is incapable of itself of altering its state! That silly negation is to be the major of your syllogisms about rest and motion: that is your grand general principle, which is to be the foundation-stone, not merely of the mathematics—that may well pass—but of the whole philosophy of motion and force.

A negative which neither contradicts nor bars out any error; a negative whose contrary affirmative is inconceivable amongst sane men, to say nothing of philosophers! The incapabilities of this dead matter are infinite. It is not capable of doing anything, where doing is the participle of any active verb. And from this infinite they select one, and politely beg our especial scientific attention to this one, its incapability of altering its state. Take care of the trap. There is a trick somewhere.

We have first a general principle; inanimate matter is incapable, of itself, of altering the state into which it is put by any external cause. Next, the general principle is applied to two cases thus: whether that (namely, that state,) be a state of rest, or a state of motion.

What does *state* mean? *Sto, stare, steti.* We know what that is in English—the verb *stand.* And the noun *status* means, if it be not a trope, just our Saxon—a *standstill.* If there is no trick, *standstill* will serve as well as the Latin *state*. Let us try it: "This is only affirming that inanimate matter is incapable of itself of altering its standstill, whether that be a standstill of rest or a standstill of motion!"

I know that some will say that this is unfair, because the words condition of rest, and condition of motion, may equally well be used. I grant all that, subject to this plain question—Did anybody ever see *conditions* or *condition* used for *state* in the manuals that employ this kind of logic? Thousands of students of dynamics can remember, as I can, that the pith of the reasoning, while it appeared satisfactory, lay somehow in that word *state*, and in nothing else. Put *condition* for *state* in this silly negation; is it thus made less silly?

Neither *conditions*, nor *relations*, nor *circumstances*, could serve the cause of Dr. Mustbeso so well as *state*, in the final phrase of his fundamental. "Inanimate matter is incapable of itself of altering its *state*, whether that be a state of rest or a state of motion." By bidding the student compare state of rest with the state of uniform motion in one direction and at unvarying speed, he withdraws the hearer's thought from changes and events that have to be accounted for, more easily than he would if he invited attention to circumstances, to relation or relations, to condition or conditions; and thus he does not to every listener lay bare the sophism of his vehement affirmation, that, in the persevering motion of our sledge, or in the rush of revolving mountains, there is nothing doing, nothing occurring, no event taking place, no change to be accounted for; but only one unchanging state before us.

I shall stick to my censure of the *standstill of motion*, although quite aware of how an Old Bailey barrister, with Johnson's dictionary in his hand, could appal the jury with my wickedness. Philosophy should be able to lay her first foundations without the aid of special pleaders.

It is false generalization, and, in the higher philosophy which knows nothing of the change of sign at zero, it will surely lead to sophism, if it is allowed to bracket together,

under one name, such opposites as rest and motion. You may as well bracket together death and life. There is no harm done to arithmetic by the juggle. But it serves the aim of sham-science to abolish the distinction between active and passive.

This may suffice as my reply at present to Dr. Mustbeso's charge of nonsensical error, in my notion of a motive power at work. More on this will require to be said in the sequel, when we discuss the cause.

He challanged me to find such a notion in any dynamical writer. We shall take a very careful look at the expressions of Laplace and of Newton, on this first law, as well as of other distinguished philosophers, and we shall be able to judge for ourselves, whether they build or not upon this grand fundamental negation about the capability of matter; and whether my hypothetical answer, or Dr. Mustbeso's direct demonstration, best expresses their views about the future continuance of this uniform motion, under the first axiom, or law.

Before I conclude this first part of my paper, I have to shew you that I have been sticking to my text. Our first question was—Can we really demonstrate, say for a week, the future continuance of the rotation of the earth? The way to do this is to demonstrate the continuance of the rotation of a single body at rest in its place on the earth, say, of a book in its place on your shelf. The centre of gravity of that book is now describing a circle, whose centre is a point given with our latitude in the axis of the earth, the axis being treated as a line fixed in space; for our rotation in our circle of latitude is in dynamics quite independent of the earth's motion in her orbit.

Since the velocity of the book is perfectly uniform, at about six hundred miles an hour, as it moves round and round that circle seven times in a week, we can conceive the

complete weekly path to be unwound, and drawn out as a right line, seven times as long as the circumference of our circle of latitude; then, choosing in that line our starting-point O, and denoting by O P the distance travelled by the book at noon to-morrow, we should have a datum and a problem before us, exactly like the one which we have been studying, except that our datum of the book's motion would be a really perfect one, and no approximation. There can be no difference in the reasoning which aims at a demonstration of the future uniform motion of the body, whether it be the book or our sledge.

Part II.

I read from my text again the assertion of John Stuart Mill about the rotation of the earth, which we are studying: "once begun, its continuance is accounted for by the first law of motion."

We have still before us our datum of a fortnight ago, a sledge in uniform motion along a level path practically frictionless, in a tube exhausted of air. It started at three o'clock this afternoon with the uniform velocity *one*, that is, of one foot in one second, and it is on its journey in that perfectly straight path of over six days' duration, under the action of no external force. The question before us is: Granted that it will so move on uniformly till noon to-morrow, nothing at all being given or denied about its progression or rest after that instant, what can we really demonstrate about its motion or rest after noon to-morrow?

The question is not what do we believe, for we all believe the same, that it will continue its uniform motion; but it is —What can we scientifically prove with demonstration?

I affirm that nothing can be proved; and that no scientific answer is possible but this hypothetic one, that if the moving power which is acting in every particle of that

sledge continues its action unchanged after noon to-morrow, the motion will go on as before: and that if that power suspends or alters its action, the motion will cease, or become a different motion.

Dr. Mustbeso and his school affirm that in the uniform motion of the sledge there is no change or event before us which can be referred to any power, force, or cause in the universe; that the body is in a changeless state, in a pure standstill of uniform motion, *i.e.*, it is in a changeless state of uniform change, in which, by virtue of its *inertia* or laziness, it must remain for ever, if no external cause disturbs it. They maintain also that my notion of a motive power at work upon the sledge is nonsense, by the verdict of universal science.

Dr. Mustbeso favoured us with what he calls a demonstration that the uniform motion must go on after noon to-morrow, just as it is now. About the logic of his proof I have given my opinion.

According to my promise, in answer to his challenge to produce scientific witness and authority, I shall now carefully consider the way in which Newton and Laplace express themselves on this subject.

Under the heading, "Axioms, or Laws of Motion," Newton writes in italics neither more nor less than this as the—First Law. "That every body perseveres in its state of rest or of uniform motion in a straight line, except so far as it is compelled by impressed force to alter that state." *Corpus omne perseverare in statu suo quiescendi vel movendi uniformiter in directum, nisi quatenus à viribus impressis cogitur statum illum mutare.* He here simply states the first postulate, without which dynamical reasoning is impossible. The principal verb is an infinitive *perseverare*, nor does any other principal verb precede in the chapter. There is no must-be. You do not find Newton decorating

himself with those contemptible rags of Ignorance which add so much dignity to the bragging philosophy of Negation.

The word *persevere* is clearly a figure of speech. Does anyone suppose that Newton attributed in literal earnest to a rolling marble the gift or the grace of perseverance? The word is a striking anthropomorphism. Do you think that Newton did not know that, or that he was unaware of the remarks that shallow criticism could make on this selection by a mathematician of a violent trope, for the principal verb of the first axiom of his stupendous work on the worlds?

Newton knew that in the court of the higher philosophy this term, *perseverare*, would pass for a figure, because he understood the Latin tongue in which he wrote; and he intended it so to pass.

Under the verb *perseverare* in Facciolati's Lexicon there are eighteen examples of the use of the word in the Latin classics, in every one of which the subject of the verb is a living human being; never an inanimate thing. We may be sure that Newton did not choose, for his very first verb after his definitions, a glaring anthropomorphism without a purpose.

A strong figure of speech in the page of a thinker of Newton's power has two uses: one is to indicate his meaning sufficiently for the business in hand; another to hide and seal up a nobler meaning, outside that business, namely, here outside that of merely mathematical reasoning, which has no concern with anything but number and measure, and never discusses the cause.

The meaning sufficiently indicated by the word *perseverare* is that our sledge is made to go on by the action of a power or force; and this action is not only indicated but expressly affirmed by Newton. The meaning which is

sealed up, is what that great and good man tied himself out from uttering concerning the conscious, intelligent, ever-purposing, and ever-working Cause of all force. How he ties himself out, and how carefully he warns the reader against understanding him to speak except in a sense and with an aim purely mathematical, any man, learned or unlearned, can see in the first pages of the *Principia,* in a small English book in the hand of Cambridge undergraduates.

Newton gives us his clear answer to the question—How does a body, say, how does our sledge, persevere? He does not make the unmeaning reply, By its *inertia;* he assigns a *vis,* an acting force, for the reason why. Under his definition in a preceding page of a different force, *force impressed,* he says: "*Perseverat enim corpus in statu omni novo per solam vim inertiæ.*" "For a body perseveres in each of its fresh states by the force of inertia and by no other." He then points out that impressed forces are referred to given origins, such as impact, pressure, or attraction of bodies; and that they do not continue or persevere unchanged after their instant of action, but cease or vary during the motion.

The peculiarity of the force under which the sledge moment after moment moves on is, that it cannot be referred to any origin given to human apprehension, and that it does persevere, not varying.

This peculiar force, if the words material and immaterial have any meaning, must be a truly immaterial force, because it has no conceivable connection with what they call the matter of any other body in the universe. This is one deep reason why my opponents are so hotly vehement in denying the action of any force, power, or cause to produce the motion before us. Nothing rouses their ire like the suggestion of a force which is not material, as they phrase it.

In spite of them, it is plainly before them all in the *Principia*, that Newton affirms the continual action of such a force not material producing the motion of the sledge. It goes on without pause, says he, by the sole force of *inertia. Perseverat per solam vim inertiæ.*

Why does he call it the force of *inertia?* Because he wanted a name, a label, for this peculiar force; the label was in use, ready to his hand. He observes that *inertia* is a very significant term; but he does not tell the reader, nor help him to find out, what it exactly signifies. This remark, *perseverat enim corpus in statu omni novo per solam vim inertiæ*, stands as one of the four lines of his definition of *impressed force;* and Newton's object there is, not to define the convenient term *inertia,* but to make it clear that the force *impressed* differs from his force of *inertia* in this, that the former force always has, while the latter has not, an origin assignable in terms of science. My opponents formally define *inertia* to suit their aim; Newton adopts it as a convenient name for a force already defined.

I have preferred to use the term motive *power,* rather than the *force* of *inertia.* With all submission, I think it better to confine the term *force,* when it is not *pressure* in contact, to those dynamical agencies which can be handled as functions of varying finite distance, under which form alone they can be made instruments of accurate mathematical reasoning, which is more than conjectural approximation. The moving power that confers Newton's *perseverance,* being uniform and a postulate in all motion, whether uniform or not, requires no symbol or formula of its own besides the first axiom stated and granted once for all.

We can easily see that this perseverance is always a part, nay, the chief part, even of accelerated motion, if we imagine the accelerating impulses to be separated by equal finite intervals of time, treating the motion much as we treat the

circle, in the study of some of its properties, under the concept of a polygon with innumerable equal sides. And we may suppose that the accelerating impulses are equal, to human perception, during the motion considered.

Let the body when at rest at the point *a* receive a tap or sudden impulse, after which it perseveres during the first time-interval, with the uniform velocity *one* over the distance *a b*. At *b* let it receive a second instantaneous tap like the former; it will move for the second time-interval with velocity *two*, persevering with the former and with the added velocity, uniformly over the distance *b c*. If at *c* it receives another such tap, it will describe in the next time-interval the line *c d* with the uniform velocity *three;* and so on. Thus a falling stone comes to the ground persevering with all the added velocities acquired from the impulses of gravitation received through all its time of descent, which we may consider as made up of indefinitely small time-intervals.

We think we understand what happens during the swift moment of a sudden pressure or impulse; but are we masters of the mystery of the perseverance of the smitten body which ensues? Ah! there *is* something wonderful, something not accounted for by their matter-and-must-be wisdom, in the motion of that sledge, which we all allow to be logically given to us, as the simplest possible experiment in physical science. We know that at each instant of its course there is acting on every particle of it a motive reason why, which they cannot call material.

We gaze, and, as we gaze, we whisper with believing Newton, persevering—quite aware of the trope that we employ—persevering all night, all night alone, undriven, uninfluenced, undeterred by any external force of any kind; all night it perseveres. And not more wondrous, not more sublime, comes to us by memory's gentle ministry that noble opening:—

"All night the dreadless angel, unpursued,
Through Heaven's wide champain held his way, till Morn,
Waked by the circling Hours, with rosy hand,
Unbarred the gates of light,"

It is thus made clear to us that Newton was no pupil of Dr. Mustbeso, and was far from comprehending either the standstill of motion or the solving power of laziness. Newton would say (were he here) that our sledge is moving on under the causation of a continual force, which is not one of those defined as a force impressed from without.

Let us next take a peep at Laplace. You will gather from one hearing of his statement on the first axiom, that my views are exactly his; that his conviction of the future motion of our sledge was an article of his belief, not a demonstrated theorem of his science; that he affirmed this uniform motion to be due to a moving force, une force motrice, whose future continued action, though believed for good empirical reasons, it is impossible to demonstrate; and that if he were here, he would give, as the only possible scientific answer to our question on that continuance, the very answer that I have given, and that Dr. Mustbeso declares to be utter nonsense by the verdict of universal science.

These are the words of Laplace, at page 138 of the *Systeme du Monde*, speaking of this uniform motion under the first law, the motion of our sledge: "The nature of the moving force being unknown, it is is impossible to know *à priori* whether that force must be maintained without cessation. It is true, since a body is incapable of giving any motion to itself, that it appears equally incapable of altering that which it has received; so that the law of *inertia* is at least the most simple that we can imagine. It is, moreover, confirmed by experiment; in fact, we observe on earth that motions continue for a longer time in propor-

tion as the obstacles which oppose them become less and less; and this leads us to believe that without those obstacles they would always continue." I have here quoted this before, and given the French in a page of our *Proceedings*.

There is something in this statement, offered as a kind of concession to an opponent dissatisfied with Laplace's avowal of utter ignorance, with his conclusion that certainty of prediction is impossible, and with his account of merely empirical grounds for simple belief. I wish to call your attention to the reason given for this concession in these words:—"It is true, that since a body is incapable of giving any motion to itself, it appears equally incapable of altering that which it has received;" after which comes the concession, "so that the law of inertia (namely, the first law, as we call it, of motion) is at least the most simple that we can imagine."

To see the exact force of this, let us look in fancy at our sledge at the instant of ten o'clock this night. At that moment two things will be true: first, it will be a body incapable of giving any motion to itself, because it is and will be an inanimate thing. Secondly, it will not *appear*, as Laplace says, but certainly *be* incapable of altering that which it has received. I ask, What motion will it have received at the instant of ten o'clock to-night, the motion then past, or the motion then future? The sledge will be in motion at the end of three minutes from now. What motion will it have received three minutes from hence? Plainly not motion then future, but then past; so that to say that the sledge at ten o'clock to-night will be incapable of altering the motion which it then will have received, amounts to this—that it will be incapable of undoing past events and of altering facts accomplished. I leave that with the young student, who will easily protect himself from the

sophistical assumption, that future motion is given of course with the past. It may be that on these good-natured phrases of Laplace have since been built the famous demonstrations of the standstill of motion, and of the marvellous energy of laziness.

The student can improve himself here by studying the anthropomorphism, or, if he prefers it, the zoomorphism, which lurks in the words "incapable of altering that which it has received." Surely, if a body is, in strict philosophical language, without a figure, capable of receiving a certain thing, it ought to be capable of dropping it and letting it go.

It cannot be too often observed, that a figure of speech in a scientific fundamental is always found in the higher court of philosophy to be a smuggler of sophism. The figure may be a most charming figure, but, if you gently knock the lady about a little, you discover that she is neatly packed with good store of materials for the production of smoke.

I shall leave the young student, if occasion should arise on this question, to deal with the logicians who can prove almost anything they please by the uniformity of nature and the invariable sequences of events, whether past or future, and to whom the future is *given* in the past.

This uniformity of which we are perpetually hearing can, I presume, only be known, really known, as a result of accurate observation in time, or in space, or in both. Considering that all the loci or spaces of the cosmos are made up of the minute elements of the loci, and that all processes in a given space are made up of the changes occurring in successive instants of time; considering also that no man alive or dead ever yet made himself acquainted with a thousandth part of all the collocations and configurations in one pin's head of any undisturbed locus, nor with a thousandth part of all the variations and sequences occurring in two consecutive half-minutes in a pin's head of

any locus disturbed,—this grand principle of uniformity seems to be not quite demonstrated. But the philosophers can judge by inspection of the finished results of change and process. Well, there are microscopic spores and germs, there are telescopic nebulæ to look at, and a good many things between these, besides the nicely carved insides of living hounds and living monkeys nailed down on tables; and the sages have so ticked off and counted, so measured and weighed, back and front, inside and outside, the perfect similarities before them, that they have established their principle of the true uniformity of processes and results, and of invariable antecedents and sequences. But did they ever really find any two products alike, or verify all through that the processes of two seconds were the same? There is, of course, similarity of leading features; there is always the succession, Spring, Summer, Autumn, Winter; but our farmers this year are far from seeing the scientific uniformity of sequences and antecedents.

This famous uniformity (to which so many writers on the profundities of philosophy conceive that they have a right of course as far as they please), when it gives its witness in the halls of accurate science, even about the present and the past, is not, outside the sequences due to gravitation, the one force whose law is accurately known to us, much to be depended upon for exact particulars; and when it there displays its philosophic insight into the defined and proved certainties of the future, concerning either mind or matter, it is about the windiest braggart under heaven.

We revert to our text and first question: What do we know scientifically about the future continuance of the rotation of this planet? Our answer can be built only on what we know about the past. Of that we know scientifically this—if Newton and Laplace were men of science—that this huge world has hitherto, we know not for how many myriads

of milleniums, been hurled round instant after instant at its equator at the rate of a thousand miles an hour, by the continuous action of a moving power. We know also that this power is different from all the forces which are known to us as dependent on masses of what they call matter, in two respects: first, that this peculiar power cannot be connected in thought with the mass or the matter of any other body in the cosmos; for dynamists are quite unanimous in their conviction that neither the sun nor any other heavenly body has anything to do with the rotation, but only with the orbital motion, of any planet; and secondly, that this moving power is invariable through the entire motion of the body that it moves, *i.e.*, it is not given to us nor conceivable to us as a function of varying distance; while every other force handled in science is either known or believed to be expressible as such a function, and consequently to vary with the motion of the body moved: that is, we know scientifically that this mysterious power is not what is commonly called a material force.

For answer to our first question, we can only say what I have already given as my only possible scientific reply to this question about the continuance of our sledge's motion, namely, this: that the continuance, the cessation or the change of the earth's rotation depends absolutely upon the continuance, the suspension, or the altered action of that invisible moving power. To this we all can add, that we believe, with a conviction practically as strong as that of scientific demonstration, that that beneficent Power will so continue in action unchanged for a time to come, very likely as long as that of its past action.

All this amounts to a confession of our faith, and not to a demonstrated theorem of our science; so that is as far as it can be from the truth, that the past and future rotation of earth is, as Mill pretends, "accounted for," that is, with

logical proof, by either the axioms or the reasonings of mere dynamics.

If Mill's assertion were true, there would be no room for farther questioning on this matter. When a proposition is completely demonstrated, it is simply laid by, with others of like rank in our scientific store, for further use when required.

There is room for me to ask another question. What is the cause of the rotation of our world, and what is the cause of the uniform motion of our sledge?

To ask is one thing; to answer is another. I am not undertaking to find the answer and to put it into your hand. There is little need of that. The soul that once asks that question, with the conviction that it is reasonable and right, that it is healthy, hopeful, and for ever good for him to ask it, that soul has already a better answer in him than learned societies can render. The first human being to whom, as he gazed on the midnight pomp of stars, or on the noonday's laughing flowers, it came to say intelligently—There is a sufficient Cause—What is that Cause?—grasped there and then the clearest and most potent thought that ever uplifted man or angel. My notion is that this Cause is a conscious and intelligent Cause, willing and acting with perfect wisdom and goodness.

By the cause of an effect, I presume that few here present, except Dr. Mustbeso, affect to understand, with Mill, a phenomenon invariably antecedent to the effect in time. If I am not misinformed, the best heads of the School for whose education Mill wrote this most delusive chapter on the Law of Universal Causation, are heartily ashamed of it, and of its absurd definitions and expositions. I have a right to use the epithets delusive and absurd, for I have here and elsewhere proved my right by reasons to which no man has replied—reasons which no man has dared to face in the

pages of other thinkers also. I do mean, to quote Mill's ironical words in his second section, "the true cause, the cause which actually produces this effect;" and the cause which he dismisses in the same page thus:—"Of the efficient causes of phenomena, or whether any such causes exist at all, I am not called upon to give an opinion." He does not deny that the verb *efficere* has a meaning, nor that there is an *effectum*, but he will not hear of an *efficiens*. That, forsooth, did not concern the theory of Universal Causation.

What I have further here to say about the Cause will be little more than an examination, for the instruction of my younger friends, of what distinguished men have said upon it, in connection with this motion under the first law.

If Dr. Mustbeso demands what right I have to affirm an efficient cause for the motions before us, I reply that my right is founded on the eternal relation of change to cause.

In the motion of our sledge, and also in the earth's rotation, I observe a series of changes which are measurable in space and time. I demand the cause of the change before me. Before I ask the doctor for his answer to the demand, it will be useful to read a passage or two from the exposition of this grand relation, by Immanuel Kant. This is better than a statement of Mr. Kirkman's opinions.

In the tenth page of his Introduction, Kant says, speaking of Synthetic Judgments:—"Take the proposition,—everything that comes to pass has a cause. In the concept of a thing that comes to pass, I think an existing fact, before which time has elapsed, and so on: from this analytic judgments can be deduced. But the concept of a cause lies completely outside the former concept, and points to something altogether distinct from what comes to pass, something not at all comprised in my thought of what comes to pass." He then goes on to show, what needs not detain us,

that the affirmation of a cause is not an analytic, but a synthetic judgment.

I turn to his chapter on the Analogies of Experience, to the Second Analogy, marked capital B, at the head of which is formally propounded for demonstration this general theorem about all change whatever:—"All changes come to pass according to the law of connexion of cause and effect;" under which is written, *Demonstration*, followed by seventeen pages of reasoning.

At page 185 (I quote from the seventh edition, Leipzig, 1828) he says:—"Now every change has a cause, which proves its causal action during the whole time through which the change goes on. Thus the cause does not produce its change suddenly, but in a time; so that as the time-interval grows from its beginning to its completion, the magnitude of the real change is generated through every smaller gradation, comprised between the first and the last degree. Thus all change is possible only by a continuous causal action, which action, so far as it is uniform, is called a momentum."

Apply this to the change from noonday glory to midnight gloom, by which the rotation of our planet is given to us, by which alone we are able to conceive or to prove the rotation. We demand the cause of this change, and of the intervening changes of aspect under sun and stars, in those twelve hours. We make the same demand in other words by enquiring—What is the cause of the rotation of the earth?

Apply the same to the changes observed in the motion of our sledge. At one instant we saw it at the distance of a yard, at another at the distance of a hundred yards from its starting point, and while we gazed, without altering our position, or taking our eyes off it, we lost sight of it.

I demand the cause of these changes of position and visibility with respect to the observer; and since by these

changes alone the motion of the sledge is definable by us, given to us, conceivable and provable by us, I make the same demand in other words by asking, What is the cause of the motion of the sledge? Will Dr. Mustbeso favour us with his answers to these two questions about the cause of the continued rotation of the earth, and the cause of the uniform continued motion of the sledge?

Dr. Mustbeso rises and says:—I hope Mr. Kirkman will pardon me for correcting a little error of his in that important section of arithmetic, Enumeration. He asks me four distinct questions, and then counts them as two. I can answer them all four.

To his first question, What is the cause of the changes of aspect under sun and stars during the day? I answer, The uniform rotation of the earth is the cause of them. Kant's theorem on change and cause entitles him to ask this question, and I have answered it.

To his third question, which he is equally entitled to ask, What is the cause of the changes of distance and visibility of the sledge? I answer, The uniform motion of the sledge is the cause of them. The third question is answered.

To ask his second and fourth questions, What is the cause of the earth's uniform rotation? and What is the cause of the sledge's uniform motion? he is not entitled by Kant's theorem on the relation of change to cause, for this good reason, that there is absolutely no change of state before him, which gives room, or call, or possibility to enquire for cause, or power, or force of any kind whatever. Both the revolving world and the moving sledge are in one changeless state of uniform motion; and, by the irrevocable decision of universal science, as it speaks to-day from the lips of every competent thinker in the world, such demand for a cause is a ridiculous confusion of ideas, and a babbling

of barbarian superstition, at the very first step of sound and emancipated philosophy.

It is not necessary for me to repeat what I have already said in reply to Mr. Kirkman, for the proof of this simple verity. I shall conclude by expressing my great surprise and sincere regret that Mr. Kirkman, quoting from page 185 of Kant's profound work, has not had the honesty to inform his hearers that on page 184, Kant, in the plainest words, withdraws every case of uniform motion from the scope of his reasoning about change and cause, and thus implicitly affirms the answer that I am giving to these questions on the motion of the earth and of the sledge.

Dr. Mustbeso sits down solemnly, amid signs of a little sensation.

In reply, I consider first the doctor's treatment of my two questions. I see no need to repeat the reasons which I have already given for my enumeration of two, not four, questions. It is sufficient to observe, that I know of no definition of a body's motion, except this one—continuous change of position of the body under observation. Whatever is true of that change of position is true of the motion; whatever is true of the motion is true of the change of position. If, then, as the doctor maintains, the motion is the cause of the change of position, the motion is the cause of the motion; for the change of position is the motion; which is absurd. Those who desire to think on this question and answer will find that quite enough. I hope they will not blame me for wasting time in bringing out this pretty shuffle of Dr. Mustbeso's. The deep importance of this whole question will plead my excuse. I beg the student to weigh well the concept of a cause stated in my quotation from Kant's Introduction: that has not yet been abolished either by the quibbles or the sarcasms of your Mills and your Cliffords.

Next, I come to the grave charge of Dr. Mustbeso, that I have concealed a plain statement of Kant from my hearers. I intended that he should bring the charge. My object is not concealment, but exposure. That statement appears as a note in small type on page 184, the fourteenth of the seventeen pages of the demonstration.

I here express my conviction, as strong as it can be short of perfect certainty, that this note is, first, a forgery, and secondly, a bungling and slovenly forgery.

I read the note in German and in English:—"Man merke wohl; dass ich nicht von der Veraenderung gewisser Relationen ueberhaupt, sondern von der Veraenderung des Zustandes rede. Daher wenn ein Koerper sich gleichfoermig bewegt, so veraendert er seinen Zustand (der Bewegung) gar nicht; aber wohl, wenn seine Bewegung zu-oder abnimmt." That is:—"Note well, that I am not speaking of change in general of certain relations, but of change of state. Therefore, when a body moves uniformly it does not at all change its state; but, of course, when its motion increases or diminishes."

Dr. Mustbeso correctly states the intention of this note, which is to exclude from the subject of the general theorem, "All changes take place according to the law of connexion of Cause and Effect," and from that of the proposition, "Now every change has its cause," already read from page 185, to exclude, I say, the changes of position that define and constitute uniform motion. The intention is to fasten upon Kant and to fix in the reader's mind this syllogism:—

All the changes included under the general theorem are changes of state.

Uniform motion is not a change of state;

Therefore uniform motion is not a change included under the theorem.

But this intention is carried out in a very bungling fashion in the note, which, instead of a major and a minor followed

by the desired conclusion, contains the major followed by the minor headed by *therefore*, without the conclusion. The muddled and confiding reader is left to make that all right himself. The muddler dared not put uniform motion into a formal conclusion, because the reader would have found him out in the next page.

The syllogism is presented in the note packed thus into two propositions :—

> All the changes included under the theorem are changes of state ;
>
> Therefore uniform motion is not a change of state.

You all see this, when I read the note again. The *but of course* (aber wohl) is no part of the argument, being denied by no one.

Neither major nor minor nor conclusion of this syllogism can be found in the whole seventeen pages. Can anyone believe that Kant would have concealed from his reader all through that long text such an important limitation of his general theorem? Can any man believe that Kant ever wrote that stupid *therefore*? When he writes *daher*, with his conclusion, you have always two premises clearly before you, whether they stand in scholastic form or not.

As to the conclusion, that uniform motion is not a change included under the theorem, you may try yourselves to pick that out of what I have already read from page 185 :—" Thus all change is possible only by a continuous causal action, which so far as it is uniform is called a momentum." These words describe nothing else than uniform motion in general. Looking at our sledge, in its change of position, he distinctly affirms that the changes are possible only by a continuous uniform causal action, which all through the motion is one ever-working causal momentum.

His next words are :—" The change does not consist of these momenta, but is generated by them as their effect."

He was looking there at the entire change in the phenomenon of the falling stone, conceived as we just now tried to conceive it, as made up of a sequence of uniform impulses and perseverances with velocities, and therefore with momenta continually increasing; and he considers every part of the entire change through the space of each small interval between the impulses to be an effect generated by the continuous uniform action of a cause, which brief action he calls a distinct momentum. His terminology is quite in accordance with that of the dynamics of uniform motion, but he introduces the cause, which it is no business of dynamics to consider, and which mock-science boldly denies.

I shall not trust my tongue to select the proper designation for the courage which in this note seeks to father upon Kant the fine logic of the stand-still of uncaused motion. The note is not *à propos* of anything in the paragraph to which it is attached, nor of a single proposition in the whole of the seventeen pages; and it is a scandalous contradiction of Kant's own words in the next page.

I am not afraid of being contradicted when I affirm that this bungling *therefore* is ample proof of forgery. I shall leave you to find out the wisdom of "change in general of certain relations," or, if you prefer it, "change of certain relations in general." How the word *gewiss, certain,* which means *not in general,* comes in the same line to be kindly holding the candle to the word *ueberhaupt,* which means *in general,* is a thing too profound for me, and it appears to snatch a grace beyond the reach of Kant.

I do not believe that Kant would have employed the Latin *Relationen,* for he invariably uses in his reasoning the better German word, *Verhaeltnisse.* Still less do I believe that in concluding a warning of such vital importance against the misapprehension of his meaning in his frequent use of the words *change* and *state,* he would have been

content with that conversational, *aber wohl;* he would have ended with a complete clause with its proper verb. Nor does it appear very likely that he would have begun his warning with that abrupt *Man merke wohl—Nota bene.*

Wherefore, with much fear and trembling at the thought of what disgrace and ruin Dr. Mustbeso may bring upon me, I drag myself forward and give in charge to the constables of science, on the strongest possible suspicion of being a bungling and slovenly forgery, this note on page 184 of the seventh edition of the *Critik*, Leipzig, 1828.

There are learned Germans among us, who will doubtless in due time give us information about the comparison of editions. You may ask—How in the world could such a forgery find its way into Kant's *Critik?* I know not. But nothing is incredible of the devices of rabid sectarian zeal. There never was a sectarianism more rabid than our fashionable Mustbeite Negationism, which has been growing now for half a century.

It is a thing of supereminent importance, it is a matter of life and death, to the Mock-Philosophy which is now so loud, to establish at this very first step of cosmical enquiry, in the presence of this simplest possible experiment in physical science, their denial not only of the action, but of the conceivableness of action, of a cause to account for the motion of perseverance affirmed by Newton in his first law. If that School fails to plant firmly this fundamental negative about the rotation of the earth, they know well what ridicule and scorn will be hurled on that grand final negation, which is to be the victorious boast of the Titanic polemic for which this philosophy, with its endless artillery of the best of good trumpets and the worst of bad logic, goes a crusading.

The answers of Dr. Mustbeso to our questions have been built on the *inertia* of matter, a word which, whatever it may

stand for in dynamical mathematics, can go for nothing in this higher court but its proper meaning—laziness.

Other gentlemen of the School prefer at this very first step in physics to reason from a position very different, almost opposite, from the *power* of matter, instead of its laziness. We read in the third definition of Newton, "Materiæ vis insita est potentia resistendi," which ascribes to matter both *vis*, force, and *potentia*, power. This anthropomorphism, *potentia*, was as deliberately chosen by Newton as his *perseverantia*.

In that most learned and difficult book, *The Natural Philosophy* of Thomson and Tait, we read in §216:—"Matter has an innate power of resisting external influences, so that every body, as far as it can, remains at rest, or moves uniformly in a straight line."

This is almost a literal translation of Newton's third definition. These two eminent mathematicians employ the tropes of Newton, and are as far as he was from the aims of our Mustbeite Negationists. They clearly consider the universe to be the work of a Cause who could have made it different and under other laws, if it had so pleased Him.

Again, I beg distinctly to say that Dynamists have a right to their own figures and phrases, in the limited range of topics, insignificant compared with the whole field of thought, which their methods can attack. After a careful reading and perfect understanding of what they have to say, I confess that, since no harm to finite arithmetic comes of it, they have a right also to that hodge-podge of unproved assumptions, violent tropes, impossible anthropomorphisms, and ridiculous misstatements of the facts and data of human thought, action, and progress, which they are pleased to call the Conservation of Energy. But I deny that the cosmos which they pretend to construct by their ideal, hypothetical, and arbitrary dynamic, either is, or is like, the world in

which I live; and I dispute the right and competence of the sophistries smuggled in under their rhetoric, to pronounce on questions of the higher philosophy.

Let us suppose that Dr. Mustbeso's learned brother George is here. Dr. George rises to answer our questions about the cause of these uniform motions of the earth and of our sledge. He reads as his own, not as a mathematician but as a philosopher, the fundamental just quoted:—"Matter has an innate power of resisting external influences, so that every body, as far as it can, remains at rest, or moves uniformly in a straight line."

He affirms that the cause of the continued motion of the sledge is this innate power of the matter in it; he affirms the same cause for the rotation of the earth, every particle of which moves uniformly as far as it can, keeping its uniform velocity, but not direction, being perpetually compelled to describe a circle instead of a straight line.

I could ask Dr. George in what way he conceives the matter of the sledge and the earth to be exercising, as his fundamental affirms, an innate power to resist external influences, when there are no such influences given or conceivable as interfering with their uniform velocity. But I refrain, because he would certainly reply, as they all do—That's metaphysics. Enough for me, he affirms distinctly that the true cause of the motions under consideration is the innate power of the matter in the bodies so to describe them. And scores of philosophers, as philosophy now flourishes, are content with that cause, and astonished to hear it questioned. I may help them to think.

Here I say to myself—granting for a moment that the matter of these bodies has this innate power—I do not see how that really and philosophically gives an answer to our question about the cause. "Dr. George," I ask, "what is the cause why your next neighbour paid his tailor's half-

year's bill yesterday, punctually as usual?" "Because he had the power to pay," replies he. "Is that a satisfactory answer in philosophy?" I demand. "The most satisfactory of all," says he, "in philosophy or in finance."

"Dr. George," I ask again, "what is the cause that another gentleman whom we know in the same ward, who has more power to pay than your neighbour, and is far more stylish in his dress, has not paid his tailor's bill for the last four years?"

"Ah!" says the doctor, "I see; the cause why my neighbour paid was, that he had both the power and the will to pay. The other's will is to gamble with other people's money on Liverpool Exchange."

Yes; the power and the will. There is no sequence in philosophy nor in nature, from power to act, but through a will. No fact, great or small, accomplished in this universe was ever accounted for philosophically by discovering the power to do it, and calling that power alone the cause.

I then ask Dr. George—"Since all our real knowledge about power and its future act is drawn from our own experience, which always testifies to the presence of will in the acts due to the power of an agent, how can it be known or shewn that the true cause of the persevering motions of the earth and the sledge is the power of the matter in them, when it is plainly nonsense to say that a man's power to pay is the cause of his paying?"

"Very easily," says he; "simply by abstraction. But, Mr. Kirkman, I decline to have a metaphysical wrangle with you. Go settle that with Thomson and Tait. When I, with those great mathematicians, assign the innate power of motion as the cause of the uniform motion in our view, we abstract. Abstraction is the peculiar glory and noblest gain of philosophy."

I answer—"I have heard of Abstraction under the head of Classification, from simultaneous phenomena. Abstrac-

tion under the head of Causation, from invariable sequences, is something new. I shall not have to trouble Thomson and Tait, for this reason, that nothing is forbidden to the rhetoric of great mathematicians, because in their mills the nonsense of their preliminary and contradictory tropes always consumes its own smoke. In general, both in philosophy and in life, this is a sound principle—Abstraction is lawful where there is permission, and no dishonest intention. In the higher philosophy all abstraction is sophistical and mischievous, unless the abstractor is ready, when called upon, to restore. You are a philosopher and an honest abstractor. From the eternal order of sequence from power to act you have abstracted will. You are ready to restore, and to say here with the voice of an honest man before philosophers, that the cause, stated without sophistry, of the motions under consideration, is the power and the will of the matter of the bodies so to move."

"No, thank you," says the doctor; "I am not so green as that."

"Then let me inform you, Dr. George, your style of abstraction, whatever be the gain of it, is before philosophy, as before the police, a disreputable calling."

I have remarked before, and I would with all my force impress it on all who wish to think closely for themselves, that the two grand verities which Sham Science is ever labouring to abolish are, first, the distinction between active and passive, and second, the relation of change to cause.

They pretend, and vulgar use supports them, that force and power are words much of the same meaning. But the consciousness and common-sense of reflecting mankind refute them every hour. Force is not power; vis is not potestas; Kraft is not Vermoegen. There is no proper power where there are not consciousness and will. Force is ever and everywhere the manifestation of acting power; but

power was never yet the resultant of forces nor the effect of force. Whatever yields to force or merely transmits it is passive, whatever exercises power is active; and the distinction between active and passive is the first dichotomy of thought, and is the very spring of all our knowledge. The word *energy*, as used in certain fine phrases of supposed science, while it never yet helped either to ask or to answer a single question of finite fact in this real cosmos, is made an instrument of sophism and of quibble in the lamest and most ambitious logic—the logic of negation.

This power, which is attributed to inanimate matter in the tropes of dynamics, when produced as a witness in the court of the higher philosophy, is proved to be a rogue. Nothing can be made out of it but anthropomorphic nonsense; and it does not construct even a tolerable figure of speech, unless the silly trope is doubled, by the coupling of power and will.

This is Dr. George's fundamental:—"Every body, by virtue of the innate power of its matter, as far as it can, remains at rest, or moves uniformly in a straight line."

As far as it can; so inanimate matter *can*. What is this *it can?* What but a survival of the fetichism of our most barbarous ancestors? Our English tongue is undefiled by another such survival, which corrupts the first conceptions of nearly every child on the continent. Our little ones are not taught to say of the quivering leaf, it is moving itself—elle se meut, es bewegt sich, si muove. Who can say that that barbarism contributes nothing to the easy spread of grovelling materialism?

I hope the day will come when from every penny manual of grammar for the lowest standard the children will learn to conjugate—"I can, thou canst, he or she can, we can, you can, they can" when *they* are living; and next to repeat from the text following, that *it can*, when *it* is not a living thing,

unless *it* be followed by *be* with a passive participle, is bad English in all serious prose, and permissible only by poetic license, as a dying echo of the strain of the savage.

I am not saying anything new. I am not the first who has lashed these two rogues, *power* and *it can*, found where they ought not to be. That profound thinker and most learned mathematician, Professor De Morgan, in his great work on the *Differential and Integral Calculus*, thus states, at page 504, the first axiom:—"The constitution of matter gives it the power (if it be right to call it a power) of maintaining its velocity in a straight line." In a highly condensed mathematical treatise he could say no more. He contented himself with lodging a protest that outweighs a donkey-load of matter-and-must-be dogmas.

If the equator of the earth were a belt of plane land, we could, without absurdity, in thought girdle the world with our exhausted tube, and have for our datum a sledge going round and round the planet at any speed once impressed, less than the velocity which would make it fly off its path in a tangent, and carrying any weight. It would be no miracle, but still the simplest case of motion.

I leave you with that phenomenon before you, to listen to the conflicting wisdom of the two Dr. Mustbesos, on the utter absence of all change or event requiring to be accounted for, and on the innate power of matter as sufficiently accounting for everything. It is a poor sort of philosophy which can build its first axiom either on helpless laziness or on innate power.

Time forbids further examination of what distinguished thinkers have written on this unsearchable fact of motion under the first law. Enough has been said to prove the assertion with which I began, that there is serious discord.

Once more I read from my text: "As we can assign no cause (except conjecturally) for the rotation itself, it is

entitled to be ranked as a primeval cause. It is, however, only the origin of the rotation which is mysterious to us; once begun, its continuance is accounted for by the first law of motion."

I am not competent to explain to you what is meant by a primeval cause which is known to have had an origin, and to have been once begun. That is too deep for me. But I can invite you to admire with me the honour that was conferred on that great thinker, Mr. Mill, when all the grand causes of the universe presented themselves before him, like the beasts of the field and the fowls of the air before our father Adam, to receive from him their rank and title. No man can fix high rank and title from the knowledge of one candidate only. What can be more heroic than Mill's own statement of his qualifications for this grand award? His bottomless ignorance! You observe that there is one thing in this matter mysterious to us philosophers—only one. My text says: "It is, however, only the origin of this rotation which is mysterious to us." But we know how to ask and how to answer nearly all about it; and that is a good deal. How did the planet get the first spin? We are up to everything except that first pirouette of Mother Earth. What knocked her into that first spin round? Well, that seems a mystery; still, we are the men that know this—Old Must-be did it somehow. But Must-be never knew how; she never knew why; she never knew when. Must-be does not know; she can neither ask nor answer a single question. She works; and she *is* a worker! Blind and deaf, ignorant and unconscious, she goes grinding on from eternity, grinding away over all and through all the depths of those heavens, and making those atoms dance for ever and for evermore. She does it all. But she never knows: she cannot understand.

Knowledge is for us philosophers. We know, we understand. She does not even know this, but we do know it—

there was a first spin, and that's a mystery! O what a glorious tingling of cosmic emotion it is that comes to us, when, standing under that starry vault, we say—All that is but the play of random, unpurposed, unthinking forces upon senseless matter; to us belong the keys of insight and the treasures of wisdom. There is no harmony till we hear and allow it. There is no design nor skill till we invent and put it there. There is no praise till we award it to our brilliant and conquering selves. O the mysterious grandeur of this cosmic emotion! Ours is the kingdom, and the power and the glory of all thought and knowledge. Whether it be science, or whether it be mystery, all—all is ours!

Thus it ever ends in the counsels of this highly fashionable philosophy. The grand close, the crowning touch is invariably with the Mystery-man. In every Bushman association, and mostly, but not always, in the British Association, the last deep word is with the Mystery-man. What an anthology you might collect of their sublime profundities about "*that mysterious thing*," about the "*inscrutable mystery*," and of the mystery theorems which they engrave deeply and for ever on their Contemporary sandhills and their Fortnightly cocklebanks!

I have been blamed for my talk about matter-and-must-be doctors. I was in the wrong. It is not proper to call them matter-and-must-be-men; they are matter-and-must-be-and-mystery-men. Those three magic words carry them victorious to the top and the bottom of everything.

Let me thank you for your patience; you need not fear any farther tax on it. There will be no reply, except the stock one—"That is all metaphysics, and the old story of angels dancing on the needle-point:" and then they will talk learnedly of something else. They know better than to answer logical challenges at the first step of their fine philosophy. There will be no answerer.

Oh! think what a miserable life I lead, unheeded by them, pining away in oblivion. Think of my doleful days, as the blue mould is creeping all over me. Think of my wretched night-thoughts as I turn in my sleepless bed, and say:—

Silence, how dead! Concealment, how profound!
Nor eye nor listening ear an object finds.
Negation sleeps: 'tis as the general pulse
Of Sham stood still, and Nonsense made a pause—
An awful pause—prophetic of her end.
And let the prophecy be soon fulfilled;
Truth, burn that curtain—we are fooled no more.

THE NEBULAR THEORY.

By ALBERT J. MOTT, F.G.S.

The Nebular theory of the construction of the universe suggested itself to philosophers about a century ago. It was supported up to a certain point by the great authority of Laplace, and by other mathematicians. Two books, published about forty years ago, made the theory popularly known in England. They were *The Architecture of the Heavens*, by Professor J. P. Nichol, of Glasgow, and the well-known *Vestiges of the Natural History of Creation*. The theory was a very attractive one, and it has been actively or tacitly adopted in modern science to so considerable an extent that its truth, or at least its high probability, as a satisfactory hypothesis, is generally taken for granted. Astronomers and mathematicians have indeed always been aware not only that real proof of it has been wanting, but that even the physical possibility of the theory has never been demonstrated; and by these it is usually spoken of, if at all, with cautious reserve. But in modern text-books, and in the general teaching of physical science, it is continually referred to as the common sense view of the way in which the universe has been brought into its present state, while dogmatic speculators, like Haeckel and many others, treat it as if its truth were as certain as that of the earth's rotation. In Professor Newcomb's *Popular Astronomy*, one of the latest and best of astronomical works, the hypothetical nature of the theory is clearly stated, and many of the objections to it are summarised in an admirable manner; but even here an opinion, though of course not a positive one, is so far given

in its favour that those accustomed to accept the theory must feel their views confirmed. It fits in admirably with the doctrine of evolution, as commonly explained. The physicist who believes in the actual dissipation of energy, adopts it almost of necessity in reasoning backwards. The geologist who assumes that the earth was once a globe of melted matter, can hardly escape the theory if he looks behind the condition of fusion; and the ultra-materialist finds the best refuge from his own specific difficulties in the unknown powers of nebulous matter.

At the same time, neither the Nebular Theory itself, nor the grounds it rests on, nor the questions it raises, are well understood except by those who have made it a matter of some special study; and considering the wide range of its influence and the importance of much that is involved in it, a reconsideration of the subject seems desirable.

In a former paper * I laid before the Society some reasons for believing that if we confine ourselves to the facts that are really known concerning the internal heat of the earth and its loss by radiation, these may be satisfactorily accounted for by the measurable quantities of carbon annually added to new deposits and annually oxydised in older ones. The nebular theory was necessarily referred to, and some of its physical difficulties were very briefly mentioned. I propose now to examine the question in more detail.

The theory was first suggested by a process of strictly scientific inference.

In the solar system the sun rotates on his axis in a certain direction. Standing ourselves in the northern hemisphere, and looking at the sun, the face he turns towards us is rotating from left to right. The earth rotates on her axis in the same direction. As we stand looking at the sun, the earth's rotation is indeed from right to left, but that is

* "On Haeckel's History of Creation." Proceedings, vol. xxxi.

because the earth and the sun turn opposite faces towards each other, like the front and hind wheels of a carriage. Looked at from a distance, both globes would be seen to rotate in the same direction.

The earth revolves in her orbit round the sun, also in the same direction. If the sun had spokes like a wheel, turning with him, and the earth were fixed to one of them, that would show the direction in which she moves in her orbit. The same thing is true also of nearly all the other planets and their satellites. The direction of their motions appears to be governed by that of the sun's rotation. All the planetary orbits also are nearly circular; all are nearly in the same plane; that plane, though not coincident with the plane of the sun's equator, is inclined to it only at a small angle, and sun, planets, and satellites are spherical in shape, or nearly so. It was a consideration of what could be the cause of these coincidences that led to the nebular hypothesis.

To understand it clearly a few elementary physical and mathematical truths must be present to our minds.

When a spheroidal body rotates on an axis, the line marking the equator upon its surface moves faster than any other part of the whole mass. The centrifugal force is also greatest along this line, both in actual amount and as a force opposed to gravity, so that if it is just sufficient here to balance the force of gravity, it is not sufficient in any other part of the rotating body, and can only become so by an increase in the speed of rotation.* Centrifugal force depends partly on the speed and partly on the size of the circle round which the particles acted upon by it are moving. It increases as the square of the velocity increases; and it increases also as

* There would be an exception to this in the plane of the equator, in a sphere of equal density throughout; but the case does not occur in nature; any independent mass of compressible matter being necessarily denser in the interior than at the surface.

the radius of the circle diminishes. With a double velocity the centrifugal force is multiplied by four. With half the radius it is multiplied by two. The force of gravity at the surface of a sphere acts generally as if the whole mass were condensed into a point at its centre, and if the sphere contracts, so that its surface is brought nearer to its centre, the force of gravity upon that surface increases according to its ordinary law. With half the radius it is multiplied by four.

If a rotating sphere contracts without any change in the velocity with which any of its particles are moving, the centrifugal force at its surface will increase, because the radius of the circle round which any of them move is shortened; but the force of gravity will increase still faster, so that the tendency to fly off will be lessened. But this is a state of things which cannot naturally occur. For if a particle on the surface of a rotating sphere moves nearer to the centre it necessarily moves through a curve which is not part of any circle that can be drawn from that centre, and the pull of attraction towards the centre will no longer be a pull at right angles to the direction in which the particle moves. A pull at right angles to the direction of motion has no effect upon the speed of the moving body, but a pull at any other angle either accelerates the speed or retards it. It accelerates it in the case of any particle moving nearer to the centre of attraction, and in a contracting sphere the speed of rotation is therefore constantly increased. The rate of increase is definite if the elements can be given, and is expressed by the law of equal areas described in equal times, and it is sufficient to turn the scale with reference to the centrifugal force, which increases in consequence faster than the force of gravity.

This is the principle on which Laplace's theory is founded, and the reason why a condensing nebula may have

its speed of rotation increased up to the point at which the ring of matter round its equatorial line might be left behind, in consequence of the centrifugal force along that ring having become equal to the force of gravity.

But the actual results in a real nebulous mass appear to be beyond the power of calculation, for they depend on elements which cannot be known. Laplace himself undertook no such problem as is involved in their solution, but began his theory with a central sun already formed.

Bearing these facts in mind, the nebular hypothesis may be shortly stated as follows:—

If the sun, instead of having separate planets revolving round him, had a vast atmosphere of heated gas or vapour, forming a great sphere round him and rotating with him in empty space, the size of that sphere would depend primarily on its temperature; the gases composing it being expanded by heat and contracted by cooling. The outer layers of such an atmosphere would be continually cooling by the radiation of heat into the surrounding space. The portions thus cooled would contract in bulk, and, becoming heavier in consequence, would drop into the hotter portions below, being drawn by gravity towards the central sun. Coming from the outer surface of the rotating sphere, they would be moving faster than the interior layers, and this speed would be further increased by the acceleration due to their approach towards the centre.

Their additional velocity would be distributed by friction through the whole mass, and the rotation of the sun and his atmosphere would thus be gradually quickened. As the speed increased, the centrifugal force would increase with it, faster than the force of gravity, till at the equatorial boundary of the contracting mass, where it is greatest, it would at length be sufficient to balance the force of gravity. When this occurred, there would be at the equator of the rotating

sphere a ring of atmosphere moving at such a speed that if left to itself, with nothing between it and the sun to prevent it from being drawn nearer to him, it would still continue to revolve round him without coming any nearer. Such a ring being established would in fact be left to itself very soon, for the rest of the atmosphere not yet rotating fast enough to overcome the attraction of the sun, and continuing to cool, and therefore to contract, would be drawn nearer to the sun and away therefore from the outer ring; till, the former process being repeated, another ring would be detached in like manner, at some distance within the first, when the centrifugal force had become again sufficient. This evidently might go on till a great part of the atmosphere was thus divided into separated rings, revolving round the sun in permanent orbits.

A ring of this kind, left to itself, would lose its remaining heat rapidly. If formed in part of metallic vapours, these would condense into solid particles. If these in the course of time drew together by mutual attraction, they might form a planet in the case of each ring. If they did so, it would probably rotate on its axis in the direction in which the ring revolved. If in the first instance the planet consisted of a nucleus of solid and an atmosphere of vaporous matter, it might itself form rings which it would leave behind in cooling, and these might condense into satellites.

In the meantime, while these planetary rings were being formed at the equatorial rim of the solar atmosphere, the great bulk of that atmosphere would be condensing upon the body of the sun, which would thus grow from a small nucleus with an enormous atmosphere, into the great central sphere of the system, such as we now find him. The speed of his rotation would gradually increase. At the period when the ring from which the planet Neptune was formed became first detached, the whole mass of the sun and his atmosphere

would be rotating at the speed necessary to detach this ring; that is, at the speed with which the planet Neptune now continues to revolve round the sun, or once in one hundred and sixty-five years; this being the speed required to balance the attraction of gravity at Neptune's distance from the centre of the attracting mass. When Jupiter was formed this speed would have increased to one rotation in twelve years, the period in which Jupiter revolves. When the earth was formed this would again have increased to one rotation in one year; and finally, the sun, condensed to his present size, rotates once in about twenty-six days. This speed is not nearly great enough to detach another ring from the equatorial belt of his present atmosphere, nor could any further condensation occur sufficient for that purpose; so that his family of planets is complete on this hypothesis.

If one sun can grow into a central mass surrounded by revolving planets in this way, there is no reason why the origin of other such systems may not be the same, and the stars, being doubtless suns more or less like our own, are supposed in like manner to have been condensed from great masses of gas and vapour surrounding a central nucleus. The complete theory indeed goes further than this, as it must do to be entirely consistent, and supposes the whole material universe to have been once merely one vast sphere of gaseous matter, losing heat, and therefore contracting, and thus resolving itself into systems of rotating and revolving bodies under the influence of mutual gravitation.

Bodies thus formed by condensation will be heated bodies. It is a curious fact that if a sphere of gaseous matter cools in free space, the more it cools the hotter it will grow. This is not a paradox, for cooling in this sense means loss of heat, and heat is not synonymous with temperature. When a gas is compressed its temperature is raised by the compression. Such an atmosphere as we have

supposed round the sun, if it contracts by cooling, comes immediately under greater pressure, because it has, by contracting, come nearer to the attracting centre, and the attracting force is thereby increased. If the density of the gas was increased by its cooling as fast as the pressure upon it was increased by its approach towards the centre of attraction, it would bear this pressure without any further reduction in bulk, and therefore without any increase of temperature; but in a spherical mass, or one approaching that shape, the pressure in such a case increases faster than the density. The gaseous matter therefore first loses part of its heat, and contracts in consequence. The increased force of gravity then compresses it still further. This compression raises its temperature, and the higher temperature tends to expand it again, and so stop the compression beyond the point of equilibrium. There is then a further loss of heat and a repetition of the process; and thus the whole mass may go on getting smaller and hotter till the pressure is sufficient to change it from a gaseous to a liquid or solid form. The effects of cooling are then of a different kind. The relation between pressure and temperature is altered, and the mass cools gradually in the ordinary sense.*

Suppose a sphere of gaseous matter to contract by cooling to half its former diameter. A sphere reduced to half its diameter is reduced to one-eighth of its bulk, and the density of the gas is therefore eight times as great as before. The whole pressure of gravity on its surface is four times as great as before, being inversely as the square of the distance; but this pressure now acts upon a surface which is only one-fourth the surface of the original sphere. A pressure four times as great upon an area four times smaller is equal to a pressure sixteen times as great upon any equal portion of

* See Newcomb. *Popular Astronomy*, 1878, p. 508.

the surface. The density being only eight times as great, it will not support this pressure except at a higher temperature, and it will accordingly be compressed still more till this higher temperature is produced. Thus we seem to account not only for the systems of the universe, but for the heat of its central orbs. The spherical shape of all the heavenly bodies is also accounted for, since fluid materials rotating on an axis would necessarily take a spherical form. But there is not much force in this latter consideration, because any materials not absolutely rigid, and especially when there are fluids on the surface, or atmospheres round them, would take this form as the result of constant rotation in the course of time.

Such is the famous Nebular Theory which has proved so fascinating to the scientific as well as to the popular mind. I shall say at once that I believe it to rest on unsound foundations, and that, like the corpuscular theory of light, it will give way gradually before reflection and discovery. Its difficulties are well known to many who use it nevertheless as a working hypothesis, and if it had been used in no other way it might have done good service to science. A working hypothesis is, or ought to be, a theory adopted with a full understanding that we do not yet know whether it is true. What we know is that a number of things appear to occur as they would occur if it were true. If many things have been observed to occur in this way, it is highly probable that there are many more, like them, not yet observed, and that by treating the theory in question as if it were true, many of these things may be discovered. This is the proper use of a working hypothesis. The constant danger, however, is that we get to treat the hypothesis, while it is the one thing doubtful, as if it were the one thing certain; to use it as proof where it is not really even evidence, and so to make it the support of speculation instead of the guide to discovery.

This is the case at present in many branches of science, and it has been conspicuously so in relation to the Nebular Theory.

I will first point out how far the theory is supported by known facts and principles, and we will then consider the objections to it.

The structure of the solar system is the first thing in its favour. The sun and planets move generally as they would do if they had been formed in this way. There are exceptions, however, which the theory does not account for. The planet Uranus revolves on an axis which is nearly at right angles to the sun's axis, instead of being nearly parallel to it, as it should be. This is as far as possible from the position it ought to have in accordance with the theory. And the satellites of this planet revolve in the wrong direction.

Looking beyond the solar system, observation has brought some support to the theory, though it is not very great. There are in the heavens numbers of shining bodies that we call nebulæ. A few of them, like those in Orion and Andromeda, are visible to the naked eye, and are not distinguishable from other stars except that they are always rather dim and hazy. But most of them can only be seen in telescopes, where they appear like little luminous clouds, or bits of the Milky Way as seen by the eye. Forty years ago it was believed that some of these were systems actually forming as the solar system was supposed to have been formed. Lord Rosse's telescope, however, showed, as soon as it was made, that many of these nebulæ were really only groups of stars, and it was then inferred that all of them would prove to be so under sufficient magnifying power. Since then, the spectroscope has revived the former belief by showing that some of the nebulæ give the light of glowing gas and not of solid bodies. But the Nebular Theory does not really gain much support from this discovery. The

gases revealed by the spectroscope as shining in these nebulæ appear to be nitrogen and hydrogen, which could not themselves condense into solid worlds. The fact that masses of gas exist in the universe is not in itself extraordinary, and supports no special inference concerning other bodies; and, finally, our interpretation of luminous spectra from very faint and very distant sources is still open to considerable doubt.

It is not certain, for example, that luminous gas may not surround a solid body from which no light would reach us. Mr. Johnstone Stoney has lately made a suggestion which bears upon this.* He has pointed out that as gases are opaque to the rays of light which make their characteristic spectra when heated, they may reflect those rays, as opaque solids would do when they fall on them from other sources. It would follow that the spectrum of any gaseous body in space might be due to reflected light, and not to incandescence. Mr. Lockyer's latest researches also show how much we may still have to learn on the interpretation of luminous spectra.

The real strength of the Nebular Theory at the present day lies in the explanation it appears to give of the source of light and heat in the sun and stars.

The quantity of heat emitted by the sun is approximately known, and it is also known that it has not varied very greatly for countless ages. The fossil remains of our own rocks, and the proof they furnish that water, rain, and ice existed here at very remote periods, leave no reasonable doubt on this point. We know also that this constant radiation of heat from a body of the sun's mass could not be accounted for without some constant source of supply. And we know that chemical action alone in the sun himself could not supply what is needed.

* British Association Report, 1879, pp. 251–2.

The necessary heat could be supplied, however, for a very long period by the gradual condensation of the solar atmosphere in accordance with the Nebular Theory.

The quantity of heat that can be produced in this way is strictly limited; but the best calculations show that the sun might, from this source, have been supplied with as much heat as he has radiated for from ten to twenty millions of years, and that if he is still, as some physicists suppose, a globe of dense vapour not yet solidified, he might go on shining as now for perhaps ten million years longer.

To do this, he must continue to condense into a smaller globe, his diameter decreasing at present at the rate of about four miles in a century. In about five million years he will, on this theory, be about half his present volume, and of course twice his present density.*

The supply of heat and light, or of the energy of which these are manifestations, is the most important of all physical facts, and the power of accounting for it is the crucial test of any theory of the universe.

It is the readiness with which it can be accounted for, up to a certain point, as the result of gradual condensation, and the supposed absence of any other sufficient cause, that has given the Nebular Theory so firm a hold upon scientific minds. I think it can be shown, however, that the objections outweigh even this powerful argument in its favour, and that there are two alternative theories, one, indeed, highly speculative, but the other strictly practical, to which the same objections do not apply, and either or both of which may be adopted as at least more probable than the current belief.

We properly reason from the known to the unknown, and when established facts lead to a necessary inference, the

* Newcomb. Page 509.

inference must be accepted with all its consequences. But if its consequences are themselves inconsistent with what we already know; if they require us to suppose the laws of nature suspended, or non-existent, at any period to which they carry us, we ought immediately to pause and ask ourselves again whether the inference is really a necessary one.

The first thing needed to make any natural theory of the universe satisfactory to our reason is that it should be sufficient for its purpose. Supposing the materials which now exist to be existing, and the forces by which they are now acted upon to be operating, any view we take of any former condition of the universe ought to be one which can be accounted for by these materials acted on by these forces. If it cannot, the theory fails us at this point. It at once becomes improbable that the state of things we have been imagining has ever really existed, and to have any reasonable ground for believing in its former existence, we must be able to show not only that the present state of the universe might have resulted from such a former state, but that it could not have resulted from anything else that can be fairly thought of as possible.

And from the very nature of the case this can hardly ever be done, for we have already brought ourselves to a conception of nature requiring the action of some Power other than the known forces of nature; and if we admit the necessity of such action at any one point, we cannot deny its possibility at any other.

Now, the Nebular Theory takes us steadily back to a period when all existing matter is supposed to have been in a gaseous state, and the first question is, whether this is conceivable under the known laws by which matter is governed. It is not conceivable as an *original* state, permanent for an indefinite time till something happened to disturb it; for matter is only gaseous when it is heated,

more or less; and all heated matter is continually radiating its heat into space, and so losing it. A gaseous universe, therefore, can only be conceived of either as due to a sudden act of creation, or else as resulting from a sufficient supply of heat from natural causes. But science can have nothing to do with original creation, or, if our knowledge really extended back to the period when this occurred, there is quite as much reason to suppose that the first created universe would be a system of worlds ready made and heated, as that it would be a system of ready heated gas.

True science, however, takes for granted that its knowledge cannot reach to the beginning of things, and that anything discoverable by scientific research must be consistent with the existing laws of nature.

The question is, therefore, whether the heat required to convert all existing matter into gas could be produced by natural causes, and we can say at once that it is impossible, unless there are causes of heat at present entirely unknown and unsuspected.

Only two original causes of heat are known to exist. They are chemical action and the collision of moving bodies. It is known that the first of these could produce no more than a very small fraction of the heat required, even if all the matter in the visible universe were engaged in it. The second cause would be equally insufficient, for, in whatever way the material of the universe were distributed, its parts could only be brought into general collision by the force of gravity; and this force could not give rise to a gaseous universe. It could not, for the following reasons. To vaporise the whole the heat must be produced very rapidly, because it begins to escape as soon as it is produced, and the effect of a slow process is counteracted by this means. But to produce it rapidly, the materials must be brought into collision at high velocities. High velocities, under the

conditions required for the purpose, are caused only by the attraction of large masses, and the materials, therefore, must be collected in bodies of great size. But such bodies, however large, and with whatever velocity they are moving, can never convert each other into vapour by the heat of their collision. Suppose two bodies like the earth meeting full tilt in space, at planetary speed. Prodigious heat would be produced at their point of contact, and much also in other parts, but the chief effect of the blow upon any existing materials would be, either to set the bodies spinning rapidly on fresh axes as they rubbed past each other, or else to shatter one or both globes into many pieces, which would fly off at once in new directions, with velocities not greatly reduced.*

The condition required, therefore, is one into which matter could not be brought by the operation of natural laws, so far as we know them, and the objection applies with equal force to a modification of the Nebular Theory, which is sometimes suggested.

In this view we are made to suppose the nebulous materials to be not expanded by heat into a gaseous form, but scattered through space in minute solid particles. But the difficulty is just the same as before. Such a state could be no more permanent than a gaseous state, unless the force of gravity were absent; while it is just as hopeless to seek in nature for any cause which could lead to such a distribu-

* I am unable to account for the extent to which this obvious truth has been overlooked. It is the well-known result of all experiments on the collision of bodies, and it must be so whenever the velocities are such that the momentum of the parts overpowers their cohesion. Unless every atom strikes an opposing one centre to centre at the same instant, the forces operating must at once resolve themselves in new lines, and in almost all directions. In the collision of two spheres especially, the area of contact at the first blow is very small. The continued motion of the other parts is opposed by nothing but cohesion and gravity; and if the bodies are, for example, as large as the sun, their outer edges are nearly a million miles apart.

tion of matter. We are driven, therefore, to suppose the existence of an unknown cause, either for the production of heat or for the scattering of solid particles, as the foundation of the Nebular Theory.

Let us suppose, however, that the nebulous mass exists. What will happen to it?

In the first place, gravity among its own particles will not cause it to rotate, unless some previous motion has been given to it.

Some of the earlier disciples of the theory appear not to have been aware of this. They supposed that if streams of matter from different directions were drawn by gravity towards a common centre, they would make a kind of whirlpool where they met, as currents of water do when they meet in a river, and that this by degrees would cause the rotation of the whole mass; or that solid portions of the cooling surface of the nebula, falling by their increased density through the gaseous interior towards the centre, would, if irregular in shape, be deflected in their path by the unequal resistance of the medium through which they fell, and so approach the centre by a spiral course, with a similar result.

But currents of water are under the influence of external forces, which in their operation are quite unlike the force of mutual attraction, and to which the whirlpool is due; and bodies deflected by the unequal pressure of a medium produce an equal effect in an opposite direction upon the medium itself. It is an established principle of mathematics that rotary motion cannot be produced in any system of bodies by their mutual gravity alone.

So that at the very outset we cannot get our nebula to turn round even, without supposing another unknown cause to be acting upon it; giving it a first push, at all events, to set it turning.

Supposing, however, that it begins to spin, it ought, according to the theory, to account for at least the whole of

the visible universe of stars. These ought to have been formed on the principle of rings. The whole original nebula ought to have turned on an axis and condensed upon a centre of attraction, and there ought to be some vast body in the middle of the system round which all the rest are revolving in nearly the same plane, and with velocities proportioned to their distance from the centre.

Astronomy gives a flat denial to the whole of this. Whatever mutual relations exist among the stars, there is no ground for believing in the existence of any such central body round which they are moving ; or for thinking that they are distributed in the same plane ; or that their proper motions accord in any way with planetary laws. It is impossible, therefore, to suppose the universe, as a whole, to have been formed in the way required out of a single nebulous mass rotating on an axis.

But the mass might break up, it is thought, into smaller portions. Each star, perhaps, being the condensed nucleus of one of these. But this is altogether improbable. It requires indeed the existence of separate nuclei in the original nebula, and if this were granted, it has to be shown how these separate portions could lose their heat, which they must do before they could condense. Heat can only be lost when the surface of a body is in contact with free space or with something colder than itself, and this would be the case only at the outer boundaries of the original nebular mass, which could thus contract as a whole, but hardly in separate portions.

Suppose it did, however, what would be the size of those portions ? The stars are at immense distances from each other, and they cannot have been nearer as the nuclei of separate nebulæ. The nearest stars are about twenty billions of miles from the sun, and we may take this distance as the probable diameter of an average nebula, such as we

are supposing. To make a mass of gaseous matter of this size, all the material in the solar system would have to be expanded to about ten thousand trillion times its present volume; that is, it would be several trillion times thinner than air. This applies, remember, to all the solid matter of our system as well as to its gases; that is, to substances like common rocks and metals, which remain solid even when all pressure on them is removed, unless they are at a high temperature. The temperature required to produce this expansion against the force of gravity of the whole mass, as well as against the molecular forces which hold the elements together, is in itself inconceivable, and if it could be produced, its effect would be to scatter the materials to infinite distances, and to make their union in one rotating mass round a common centre of gravity impossible. For a hot gas is a gas in which the molecules are flying with high velocities in all directions, and if these velocities are sufficient to overcome the force of gravity to which the gas is subject, the molecules at the outer surface will be continually projected into free space, and will never return. It is the relation between the molecular velocity and the gravitating force that puts a limit to the gaseous atmospheres of the earth and other bodies. Where the air above us is so thin that the free path of its molecules becomes uninterrupted, these fly outward with a certain velocity which depends on their temperature. If this were more than sufficient to overcome the earth's attraction, they would fly away for ever. As it is less, they fly to a certain distance and then return, like arrows shot upwards and falling back again. The outer layer of our atmosphere can only consist of gaseous molecules in this condition, and its extreme limit is determined by the distance to which their velocity of projection will carry them before gravity causes them to turn back. If they started from the surface of the earth with a speed of one mile a second,

they would ascend about a hundred miles and then fall back, supposing they neither encountered resistance nor received fresh impetus. With a speed of seven miles in a second they would leave the earth for ever. Some of them probably are really carried to a distance of two hundred miles from the earth, though hardly beyond this. * But this is because the force of gravity drawing them back is exerted by the mass of the earth while they are only four thousand miles from its centre. But the force of gravity exerted by the whole mass of the supposed solar nebula upon the particles at its own outer surface, at a distance of ten billion miles from its centre, would be so small, that any particle projected outwards with a velocity of about four hundred feet only in a second would never return. If the nebula were only one-tenth of this diameter, its radius being then only one billion miles, and its mass the same as before, a velocity of thirteen hundred feet per second would still carry the projected particles permanently away. Considering the temperature that must be assumed, and the molecular velocities corresponding with it, it appears certain that any such nebula, instead of condensing, would dissolve of its own accord and vanish in infinite space. I believe that this consideration alone renders the whole theory incredible. †

I have reminded you that in the case of the solar nebula the supposed nebulous mass would, on the theory, be some trillion of times thinner than air. There is nothing inherently impossible in this extreme tenuity of matter as far as we know, but it is quite certain that we cannot tell what would

* There are no indications of an atmosphere beyond this limit, which corresponds very well with what is probable as to the maximum velocities of oxygen and nitrogen overhead.

† The velocity required to carry a body permanently away from an attracting centre is $\sqrt{2. R. G.}$ R being the distance from the centre, and G the acceleration due to gravity at that distance. When the mass is the same, the velocity is inversely as the square root of R.

happen under the circumstances. Mr. Crookes has shown that when gases are reduced to about one millionth of their common density they acquire properties of a wholly unexpected kind. And if this is the result when a gas is expanded to a million times its common bulk, what are we to look for when the expansion is a billion times greater? We must feel that the behaviour of matter in this condition would assuredly be very unlike anything we are acquainted with, and that to reason upon it as if we knew what it would do is a philosophical mistake.

But let us suppose the nebulous mass acted upon by ordinary laws, and in the state in which the first revolving ring would be left behind. It is probably beyond the reach of mathematics to determine the real distances or dimensions of the rings that would be thrown off on the hypothesis, but there are a few unavoidable results which show the theory to be inadmissible.

If the revolving mass were a flat disc of equal thickness and density throughout, turning on an axis perpendicular to its plane, and contracting equally upon its own centre—the revolving particles maintaining the law of equal areas described in equal times, and the force of gravity considered as affected only by the distance from the centre and varying as the inverse square—then if A be the radius of the disc when the speed of revolution is just sufficient to balance gravity at its outer rim, so that a ring can be left behind—B the radius of the disc inside the ring, and C the radius to which this must contract in order that the increased velocity may again become sufficient to detach a second ring—it will be found that $C = \frac{B^4}{A^3}$.* That is to say, the contraction

* If A, B, C are the three radii, and x, y, z the several velocities at those distances, then

$$\begin{array}{lllll} A & : B & :: & x & : y \\ C & : B & :: & y & : z \text{ (To describe equal areas).} \\ \text{and } z & : x & :: & \sqrt{A} & : \sqrt{C} \text{ (To balance gravity).} \end{array}$$

required depends on the difference between A and B, which is the thickness of the first ring. If this is small in proportion to the radius, the distance between the rings will also be small. It will not indeed be more than three times the thickness of the ring. It would be still less if the reduction in the mass due to the separation of the ring were also considered.

Now, the case of a rotating spheroid differs from that of a disc; the detachment of a ring would slightly lessen the attractive force; and different densities, with different rates of contraction in the whole mass, would alter these proportions; but it would always be true that the distance of the second ring would depend on the thickness of the first, and that if one were very small in proportion to the radius, the other could not be great.

But the thickness of such a ring must of necessity be inconsiderable; the velocity of rotation required to detach it is gained first at the actual surface and nowhere else at the same time, and the ring itself can be nothing but a superficial film, except so far as the cohesion, or attraction, or friction of its particles enables them to carry with them some portion of the material within it; and this is impossible to any great extent when the material is gaseous.

Nor can the ring be very broad; for the same reason. The actual velocity required is attained first only along the actual equatorial line of a rotating spheroid, and not, at the same time, at any point on either side of this line. The difference in velocity is certainly very small over a belt a few degrees wide, but at about 7½ degrees from the equatorial line it reaches the proportion of 99 to 100; a difference which would require considerable cohesive force to overcome it.

But the planets of the solar system are at vast distances from each other. The nebular theory obliges us to suppose

that, after throwing off the ring of which Neptune was formed, the solar nebula contracted from a radius of 2,700,000,000 miles to one of only 1,700,000,000 before another ring was detached, these being the distances of Neptune and Uranus. The contraction is 1,000,000,000 miles, and is more than one-third of the whole radius; and it involves a thickness in the first ring which from any point of view is absolutely incredible.

The impracticable nature of the theory is very well disclosed if we apply it to the formation of the moon. On the nebular hypothesis, the moon has been formed from a ring of gaseous matter, detached from the earth when in a gaseous state. At the time of its detachment the earth must have been a spheroidal nebula, whose diameter was that of the moon's present orbit. The whole mass would be 216,000 times its present bulk, and its mean density would be about one-fourth that of hydrogen at normal pressure.

Now, at the surface of this nebula, anything projected with a velocity of rather less than one mile in a second would fly off for ever, and would not return. The temperature of the mass must on the hypothesis be sufficient to hold all the solid matter of the present earth in a gaseous form. The density of the moon, and her external appearance, show that she is formed of materials not unlike those we are acquainted with, and these, therefore, must have been existing as gas in the outer layers of the nebula. The temperature necessary is certainly not less than 5,000° F., and is probably very much higher. For convenience, I shall assume it to be 7,412° F., which is sixteen times the temperature of the freezing point of water on the absolute scale; absolute zero being taken as − 460° F. The mean molecular velocity of gases varies inversely as the square root of the molecular weight, and directly as the square root of the absolute temperature; and at 7,412° F. it is therefore four times the

velocity at freezing point. Taking the mean velocity of hydrogen at 32° F. as 6,000 feet per second, that of the following elements will be as under at the above temperature, of course in round numbers :—

Hydrogen	24,000	feet.
Oxygen	6,000	"
Nitrogen	7,000	"
Chlorine	4,000	"
Sulphur	4,500	"

These are the mean velocities according to the modern dynamic theory; the maximum velocity of many molecules is probably very much greater. The nebula must also be supposed to have existed in a much more expanded form before the moon was detached, and the velocity required to carry bodies away from its surface would then be proportionately less, while the temperature required to convert solids into gases would be the same. It is clear, therefore, that none of the five elements given above could have remained in the nebula. Their molecules, as they reached its surface, would fly off into outer space. Nor would the velocity needed to carry them away from the nebulous mass be, in fact, nearly so great as I have supposed; for at the distance of the moon's orbit from the centre of the earth, the sun's attraction is greater than the earth's, and it is in virtue of her orbital motion round the sun, and not in virtue of the earth's attraction, that we now retain the moon as our satellite. If the earth and moon could be stopped in their orbits, and the earth held fast, the moon would at once fall to the sun. Bodies projected to an inconsiderable distance from the surface of the nebula would not, therefore, return to it. That any hydrogen, oxygen, or nitrogen should remain in it appears wholly incredible, and it is questionable whether matter of any kind at the moon's distance could condense upon a nebulous earth at all by simple gravitation.

Passing by this objection, which, nevertheless, is fatal to the hypothesis, let us consider the size of the ring. The moon's mass being about one-eightieth of the earth's, the ring must contain one-eightieth of the nebula. Supposing it to be fifteen degrees in breadth, which, as we have seen, is more than could be allowed, and supposing the density of the outer parts of the nebula to be equal to its mean density, which is again incredible, the ring would then be about 8,000 miles in thickness. But its inner surface would then be 8,000 miles nearer than the outer one to the axis of the sphere. This is one-thirtieth of the radius. The centrifugal force at the inner surface would therefore be less, in the proportion of 29 to 30, while the attractive force to be overcome there would be greater. The inner surface would be moving with only about nineteen-twentieths of the speed necessary to detach it, and it could only be detached by a cohesive force impossible in a gaseous substance.

These calculations, moreover, are all made on the assumption that the density of the nebulous mass is uniform throughout. The real distribution of density in such a nebula cannot be given, but there are no conceivable conditions under which it would not be greater in the interior than near the surface.

But if the superficial layers were of less than the mean density, as they must necessarily be, the ring must be either broader or thicker than has been assumed; and to extend it in either direction is to increase, and in an increasing ratio, that difference in the velocity of its parts which has been shown already to be fatal to the theory.

The throwing off of the supposed planetary rings from the supposed solar nebula will be found equally incredible if examined in the same way.

And supposing such rings to be formed, it has been taken for granted that they would coalesce into spherical masses

by reason of the mutual attractions of their parts; but I believe there can be no doubt that this is an unwarranted assumption. Considering the necessary dimensions of these rings, it seems clear that if they divide into separate parts, some of these parts will move more slowly than others; their orbits and their periodic times will therefore be different; and in what way they can be brought together so as to form one body is incomprehensible. We see in the meteor rings so recently discovered what really happens when a number of small portions of matter revolve round the sun in nearly the same path. They do not gather together into one body, nor is there any reason to think they can do so.

There is still another objection. When gases and vapours are mixed together, the laws of gaseous diffusion prevent them from separating, as liquids of different specific gravities might do; but, nevertheless, the lightest gases will be found in the largest proportion at the surface of a gaseous sphere. If they are in equal quantities at the centre they will be in unequal quantities at the surface, the lighter preponderating there; so that the outer nebulous rings would always consist of lighter materials on the average than the interior mass.

Now, it has been thought that the Nebular Theory derived some support from this, because the density of the four exterior planets has been supposed to be much less than that of the four interior ones; leaving out the asteroides. You find in astronomical books that the density of Jupiter is about one-fourth that of the Earth, of Saturn one-eighth, of Uranus and Neptune between one-fifth and one-sixth. It is known, however, that these densities are less than the truth. The only question is, how much less? The total weight of these planets, compared with that of the earth, is known pretty accurately from the motions of their satellites; but their density cannot be known unless we know their size as

well as their weight. Their size can only be learned by measuring their diameters as we see them; but all these planets have dense atmospheres, and what we see is the surface of their atmosphere, and not the solid body within it. The apparent diameter of Jupiter is 85,000 miles; but if his atmosphere is 15,000 miles deep, the density of his solid body is really as great as the earth's, instead of being, as has been supposed, only one-fourth of it.

And when we leave Jupiter, the next four planets—Mars, the Earth, Venus, and Mercury—instead of becoming denser by degrees, are all of them very nearly alike in density. And in the case of these planets, the true density is known within narrow limits, because none of them have atmospheres of very great depth. Yet as the distance of Mars from the Sun is twice as great as the distance of Venus, the solar nebula, which extended to the orbit of Mars when that planet was thrown off, must have contracted to one-eighth of its bulk before Venus was formed. And yet the average density of the materials forming these two rings must have been about the same. This is contrary to the natural laws relating to diffusion.

Some other curious results of the effect of heat upon gaseous bodies suggest themselves here. The velocity of projection from the earth's surface which would carry any particle away for ever, is about seven miles per second. It is somewhat less on Venus and Mercury, and on Mars it is about three miles. It is thirty-three miles on Jupiter. All these planets, therefore, are able to retain an atmosphere of ordinary gas if not violently heated, and none of them are likely to shoot off volcanic matter into free space.

On the moon, however, the necessary velocity is reduced to a mile and a-half, and it is less than a thousand feet per second on all the minor planets. It appears, therefore, that none of the minor planets could hold any gaseous atmosphere

on their surfaces unless the cold was very great and constant, and that probably the moon herself could not do it, from the high temperature to which her luminous side is raised every fortnight, and for a fortnight together. On this account we should expect to find no atmosphere in the moon, which accords with observation. The existence in space of great masses of gas, such as the nebulæ are supposed to be, can only be accounted for on the supposition that their temperature is low enough to reduce their molecular velocities to a few feet, or even inches, in a second. This, of course, is the probable condition of such bodies, floating in space, with a prodigious extent of surface in proportion to their mass. Their temperature is likely enough to be little above absolute zero. But at such a temperature most of the elements become solids under any circumstances. Hydrogen and nitrogen appear to be the substances that can endure the greatest degree of cold, without losing their gaseous form; and these are, in fact, the gases which the spectroscope appears to find in the nebulæ.

Comets, there is reason to think, are not purely gaseous bodies, though the presence of gas is indicated. And notwithstanding the general belief to the contrary, we may, I think, be sure that a comet as a whole is intensely cold.

Suppose one of these bodies, 100,000 miles in diameter, to have a mass equal to that of the moon—a perfectly extravagant supposition. At its surface, anything projected with a velocity of 1,000 feet in a second would fly off into space. That such a body could hold together as a highly heated gas is clearly out of the question.

A somewhat different view of these strange objects may, I think, be suggested. Supposing a comet to be essentially a group of meteoric stones of average size, these will not be able to retain any gaseous atmosphere around them, except at a very low temperature, but a considerable quantity of gas will

be occluded in the stones themselves, if they are like those that reach us; and as they move in vacuo, a small increase of temperature may cause some of this gas to escape. While the comet is approaching the sun its temperature is rising. Each stone receives an uninterrupted blaze of sunshine. They probably rotate on axes, and so are warmed all round, and though the radiation of the heat received will be extremely rapid, there must be a constant increase in the escape of gas during their passage from aphelion to perihelion. Now, the gaseous molecules thus projected into space beyond the limits of the meteor group will be subject practically to the sun's attraction only, that of the stones they fly from being far too small to control their motion; and it will be seen immediately that none of them can return to the comet except those projected outwards along the line joining the comet and the sun. These will fly off to a certain distance, determined by their velocity, and will then fall back towards the sun along the same right line; that is to say, in this one direction the stream of particles flying off will be met by another stream returning, while in all other directions the current will be outward only. The encounters of these two molecular streams would doubtless result in light, and a line of light extending outwards from the comet directly away from the sun would be the result. The lines spoken of as right lines would of course be curves in fact, on account of the comet's orbital motion, and the usual shape and direction of a comet's tail seem to correspond to what might thus be expected to appear. The molecular velocity required is, however, considerable. At the distance of the earth's orbit the molecules must fly off with a speed of about two miles and a half per second, to carry them one million miles directly from the sun before they began to fall back; eight miles per second would take them about ten million miles; eleven miles about twenty million. But the falling molecules

being retarded by their encounters with the ascending ones, while the comet moved forward in its path, the length of the tail may be extended much beyond these limits. On this view, comets moving the most rapidly should have the longest tails.

The velocities spoken of are much above the *mean* velocities of gases at the probable temperature, but not necessarily above the maximum speed, and the faintness of cometic tails at their extremities would naturally result from the small number of molecules projected at the highest speed. That the tails should increase in length as the comet approached the sun would probably follow, though this would in part depend on the rate at which their temperature increased, compared with the increasing force of gravity. In the body of the comet itself, that is, within the group of meteorites, there would of course be frequent encounters among the gaseous molecules, these being discharged in all directions from each separate stone, and the luminous coma might be thus accounted for.

That nebulæ should be luminous at extremely low temperatures is no doubt a matter that has still to be explained, but the phenomena of phosphorescence and of electric light, and Mr. Johnstone Stoney's suggestion as to the reflection of light by gaseous bodies, give sufficient reason to think that an explanation will be found. We may even look for it, perhaps, in the probable fact that light vibrations accompany all temperatures, and that when received by the eye in sufficient quantity, as we may suppose them to be when they reach us, not from the surface only, but from all parts of the mass of a vast body of transparent gas, those associated with the lowest temperature may be luminous to our sight.

The objections to the nebular hypothesis meet us thus in all its stages from first to last. As soon as it is tested in its practical details, we find it to be not only incapable of proof

but irreconcilable with the known facts and laws of nature. Its common acceptance has been due to a too hasty adoption of general ideas without considering sufficiently the conditions of their application.

But reasoning against it will hardly seem conclusive unless some alternative theory is proposed, by which so much of the facts around us as the Nebular Theory would really explain if it were true, may equally well be accounted for. I said there were two such alternative theories. The first is purely speculative, that is to say, we cannot at present appeal to any real knowledge in direct support of it, and yet there are considerations which give it serious weight.

The chief point in the matter is to find out the source of heat in the sun and stars. On the Nebular Theory the heat they radiate is not accounted for in the first instance, but it is afterwards, and all they radiate is supposed finally to be lost. Infinite space is believed to be filled with the interstellar ether, and through this the heat vibrations, after leaving the universe of solid matter, are supposed to travel for ever, the ether itself remaining entirely unchanged by their transmission, retaining no part of their energy, and having no power to bring them back in any form. This is, I think, an unsatisfactory and unscientific view to rest in. Ethereal vibrations, like those of matter, require a definite time to traverse a definite space. There is, therefore, a resistance to overcome, and we know that in every other case where resistance is overcome force is developed in some form not identical with that which overcame the resistance. Ether, therefore, through which vibrations have passed, ought not to be exactly as it was before they passed, unless it has produced some change in something else. Now, there may be a something else, which is to the ether what ether is to matter, or ether itself may be capable of developing force in some other form than that of vibration. But in either case the waves of

heat, in passing through unlimited space, ought gradually to disappear, though at a rate not appreciable in the distances to which we can apply any test; and the ethereal ocean should be constantly charged with the energy thus constantly accruing. If so, this energy is not lost, as has been supposed, but is everywhere about us in some form not yet detected, and is no doubt capable of reproducing the heat from which it was derived, if there are any bodies in the universe by which a reversing process can be applied to it; just as an expanded gas can reproduce the heat which caused its expansion, if there is anything that can compress it, or as a flying shot can reproduce the heat of the gunpowder, if there is anything that can stop it. The chief difficulty lies in understanding how a body like the sun can act upon the ether so as to derive his heat from it, while his planets have not the same power, at least upon their surfaces. But suppose it should be not at the surface but in the interior of solid bodies that the reconversion of ethereal energy into heat occurs, and that as the mass of a body increases, the power of effecting this reconversion increases in a higher ratio? There is nothing unreasonable, or even improbable, in either of these suggestions, though of course they are at present purely speculative. Definite solutions of the problem have indeed been attempted, as by Mr. Mathieu Williams in "The Fuel of the Sun," and that the interstellar ether absorbs energy, and must in some way be able to reproduce it, is in itself a legitimate induction.

It may be observed that, supposing the ether to be charged continually with fresh radiant energy from the bodies floating in it, the reappearance of this energy in the form of heat need not necessarily be continuous, but might be brought about suddenly, and at long intervals of time.

The second alternative is one which has been considered and rejected as inadequate by our best physicists, but I think

this has been due to the sudden interest excited by the contraction theory, and that it has been rejected on what in fact are wholly insufficient grounds.

The most powerful source of heat known to us is the collision of bodies moving at high velocities. The quantity of heat that any moving body can produce is, in theory, limited only by the velocity that can be given to it, and though this is far from being true in practice, there are no heated bodies whose temperature could not easily be kept up for an indefinite time by constant blows from comparatively small objects, moving very fast. The whole heat radiated by the sun, it is calculated, would be continually supplied if a quantity of matter, equal to the mass of the earth, fell upon him from surrounding space every century, with the speed which the sun's attraction would give it.

There is no doubt that some matter does fall thus upon the sun. Our own experience of meteors is a proof of it. The earth encounters these bodies in moving through space. The sun doubtless must encounter more of them. It has been assumed, however, that the quantity could not possibly be great enough, because as only a small fraction of the meteoric bodies in the solar system, or encountered by it, could strike the sun, their total number would have to be immense.

"If meteors," says Professor Newcomb, "were as thick as this, the earth would be so pelted with them that its whole surface would be made hot by the force of the impact." *

But there is another side to this question. The sun is not stationary in space. He moves through it, carrying the planets with him at the estimated rate of about 200,000,000 miles in a year.† The nearest stars are about

* Newcomb, pp. 506–7.

† This is rather more than the usual estimate, but the sun's dominion over space extends on all sides so vastly beyond the assumed distance, that the numerical results given are very far below the truth.

twenty billions of miles from us, and supposing them to be as large as the sun, he will be the ruler of the space through half the distance. His attraction will determine the destinies of all material bodies within ten billion miles of him on every side as he moves along. At that great distance, indeed, the speed of his own motion may in many cases carry him away faster than he can draw bodies after him, but we need not follow his authority into such depths of space. Let us suppose his rule to extend to only twice the distance of Neptune, which is not one-thousandth of the distance spoken of before. As the sun moves along, all material bodies within this distance will be compelled to fall on to him or to revolve round him, unless they are already moving rapidly in certain directions.

Bodies at rest, or moving very slowly, or moving towards the sun when he approaches them, will either fall directly on him or revolve round him in orbits determined by their previous motions. The slower these have been in general, the nearer will they approach the sun at their perihelion.

Now, it is clear that if the space the sun passes through contains bodies that can be drawn towards him, the number thus revolving round him must continually increase, and must have kept increasing through all former ages, and those whose orbits bring them near to the sun must often come into collision and interfere with each other when they are sufficiently numerous and drawn from different parts of space; the result will be that many of them will fall into the sun, and if the supply is continuous there will be a certain *maximum of concentration* round the sun's immediate neighbourhood which cannot be exceeded, the number falling into him being then equal to the supply. There is strong reason to believe that the sun is in fact surrounded by a cloud of small bodies of this kind, the accumulation

being thickest near his surface, and gradually thinning off to a great distance round him. The zodiacal light especially supports this belief, and it accords exactly with what might be expected, except that it extends in one direction only; but this may probably be accounted for by the action of the planets, and by another cause to which I shall refer afterwards.

The question, then, is whether the supply of fresh matter thus drawn to the sun from year to year would really be sufficient to maintain the heat he radiates. To determine this we must consider the probable sources of meteoric matter and what is known concerning its quantity in space.

The idea that space is traversed everywhere by small moving bodies is not a familiar one. We see the sun, moon, and stars, and the vault of heaven seems otherwise empty; but the study of meteors during the last few years has shown that this is a mistake due to the small power of our vision. Millions of small bodies are always moving over our heads, none of which can ever be seen, unless they happen to come near enough to enter the earth's atmosphere and become ignited by its friction. When they do this we call the smaller ones shooting stars, the larger ones meteors. Many of those which thus enter the atmosphere are dissipated there by the heat of their ignition, and only reach the ground at last in impalpable dust, which indeed is always falling, but in too minute a form to be easily detected. But many of the larger ones, probably all that weigh more than a few ounces, fall bodily on the earth. When a very brilliant meteor is seen in the sky one of these is passing through the air, and is probably not less than five or ten pounds in weight. Some of them weigh several hundredweight, or even tons; they often explode and fall in many pieces, and they strike the ground with force enough to bury

themselves several feet deep in common soil; they are falling every day, perhaps every second, upon some part of the earth. Many of them consist chiefly of iron, but many also are of stone, like fragments of volcanic rock. The British Museum has a collection of several hundreds of all kinds and sizes, the largest weighing nearly four tons, and information concerning them has been rapidly accumulating in the hands of the committee appointed by the British Association. The fall of large masses as well as small ones is now known to be of frequent occurrence. The composition of these bodies, as well as their shape and structure, strongly suggest that many of them, at all events, have been shot from volcanoes, though they are not exactly like the stones of our own volcanoes. Dr. Ball, Astronomer Royal of Ireland, has very lately calculated the conditions under which such fragments could come in contact with the earth if shot from any of the bodies in the solar system, and has found that it would be seldom possible, unless they came originally either from the sun or from the earth itself.* When Etna or Vesuvius is in eruption great showers of stones are shot violently upwards, but it is certain that at present they all fall back again; whether they will do so or not is simply a question of their velocity.

It is supposed that in former ages volcanic action may have been so violent that the necessary velocity might be given by it, and that the larger meteors may be fragments thus ejected, which have been revolving round the sun ever since, and which the earth is now slowly recovering, picking up some of them every time she passes the points where they cross her orbit at the moment that they themselves are passing.

But there are no solid reasons for supposing that the ancient volcanoes of the earth were powerful enough for the

* *Nature.* Vol. xix., p. 498.

purpose,* or that the substances then ejected would be exactly like the meteoric stones. The limit of possible velocity in projectiles is not known, but it depends very much on the pressure that can be applied before an explosion takes place, and as pressure in volcanoes depends chiefly on the force of gravity, we may expect the explosive energy to be greatest where that force is greatest, that is, in the largest bodies of the universe.

This quite accords with what has been observed in the sun. Jets of hydrogen have appeared by means of the spectroscope to burst from the sun's border at a speed of between one and two hundred miles in a second. This is only about half the speed necessary to shoot anything from the sun so that it will not fall back to him; but it is incredible that gas alone could be projected at such a speed, even through a thin atmosphere, unless assisted by more solid matter moving still faster, and it is very probable, therefore, that matter of some kind is driven away by explosive energy from the sun into space. The outer layer of any atmosphere containing hydrogen must be expected to consist of this gas in a state of extreme attenuation; and in a highly heated atmosphere this layer must be of considerable depth, because the velocity of molecules of hydrogen is very much greater than in the case of other known bodies; and this, at a high temperature, must carry them, before they fall back, to a great distance from that outer surface of the atmosphere where their free paths cease to be interfered with. If this view is correct, the sun should have an outer sphere

* The resistance of the air to anything shot through it, increases nearly as the square of the velocity. It is very unlikely that any meteorite ever strikes the ground with a final speed of even two or three miles in a second. The volcanic force required to drive a projectile through the atmosphere so that it should leave it with a speed of seven miles in a second, is, I think, inconsistent with anything we know concerning terrestrial forces or the geological evidence of their power in former ages.

of probably unmixed hydrogen, excessively thin, and instead of supposing the red flames to be caused by the actual projection of the heated gas, a supposition involving great difficulties, we might assume that a discharge of dense volcanic matter has taken place through this gaseous envelope, the intense heat of friction making the gas luminous as it passes. I leave it to skilled observers to consider whether the actual appearances may not be thus accounted for.*

Matter shot from the sun cannot, however, be the probable source of most of our own meteorites. They are all of them bodies revolving round the sun, and the conditions of our meeting them are, that they happen to cross the earth's orbit, and that the earth happens to be at the crossing point when they are passing. The earth's path is of course only the width of her own diameter, and meteors, at their usual speed, cross it in a few minutes. The number of meteors, small and large, that we actually receive is prodigious, not less than 400,000,000 in twenty-four hours. Yet our meeting with any one of them may be almost called accidental. What, then, must the whole number be, revolving always in all directions round the sun? It must be inconceivably great, and we must look for some source that will furnish so many of them that even our faint chance of meeting even a single meteor gives us 400,000,000 of them every day.

* The resistance due to a velocity of 400 miles per second is so overwhelming that it is incredible that any explosive force at the bottom of the sun's dense atmosphere could drive a shot through it, supposing the atmosphere to be at rest. But the cumulative force of a continuous discharge of gas from a solar volcano would, after a sufficient interval, establish an upward current, perhaps of great height, and solid bodies shot through it would then meet with no resistance till their speed exceeded that of the current. The seat of the explosions themselves may, moreover, be in the atmosphere itself, far above the surface of the sun.

There is, I think, no conceivable source which can compare in probability with that already suggested. If the sun, in his grand path among the stars, sweeps the space all round him with the great arms of his attractive power, drawing into orbits round himself the scattered materials he meets with, it follows necessarily that if there are any such materials to gather, he must in the course of ages have drawn an almost infinite number into such orbits; and if other large bodies like the sun shoot out materials which do not return to them, the interstellar spaces will be sprinkled everywhere with these small objects.

Let us see with what degree of closeness they must be sprinkled, if the matter thus drawn to the sun is sufficient to supply his heat by falling upon him.

It is required that a mass equal to that of the earth should be drawn into the solar system from outer space every century. Supposing that it is all drawn from a distance not exceeding twice that of Neptune's orbit, and calculating the space of that diameter swept by the sun's attraction in his onward course, it would require about one ounce of matter in every 8,000 cubic miles, which is a space twenty miles square by twenty miles high, and an ounce of meteoric matter is about equal to three penny-pieces. So minute a quantity diffused through space would be imperceptible to our senses. It is not equal to one particle of the finest dust set floating in a very large room. But meteoric bodies are not equally diffused, but are collected in groups, probably pretty close together, before they are drawn into regular orbits. If such groups contained a million of them on an average, the groups might be 2,000 miles apart, instead of twenty; if a billion, they might be nearly as far apart as the earth and moon; and a billion of such bodies would not weigh as much as a large iceberg. As far, therefore, as perception by the eye or the telescope goes, the

quantity of matter scattered through space might be enormously greater than is necessary without our knowing anything about it. It might indeed be almost indefinitely greater, for I have supposed the sun's rule to extend to only twice the distance of Neptune, that numbers may be used which can be readily conceived.

But, in fact, the sun governs the motions of all material bodies on all sides, till he meets some other force more potent than his own, and the numbers given may be multiplied by hundreds or thousands without exceeding the limits of probable truth.

Besides volcanic action in the stars, there is another probable source of scattered fragments in the interstellar spaces. The meteors which strike the earth have been revolving round the sun, it may be, for millions of years before their course is stopped by this sudden catastrophe. We may call them microscopic planets. They are to the larger planets what bacteria are to men. And the catastrophe which puts an end to their independent existence is one to which the larger bodies are equally liable, although at much longer intervals of time. Their paths in space must sometimes cross each other, and occasional collisions among them must be looked upon as necessary parts of the general order of Nature. Such collisions, between two suns for example, would scatter fragments of all sizes far and wide. The large fragments would probably become the planets of the new sun which would be formed, and if this is the origin of planetary bodies generally, it would account, I believe, for the general facts of their constitution, size, and motions, as far as we know them. The small fragments would add to the common stock of meteoric matter in the universe.

Fragments thus detached from very large bodies would undergo great changes from the expansion of gases con-

tained in them when the pressure of gravity was suddenly reduced; many might probably explode immediately.

All matter flying away from an attracting body through open space to a great distance gradually loses its speed, and the contents of volcanic discharges when shot away would keep together in groups; some fragments, however, taking separate paths. Very large stones especially would be likely to do this, as they force an independent way more readily through gas and vapour. What the sun, therefore, should meet with in the space he sweeps would be groups of small meteoric bodies travelling together, and detached masses, usually of a larger size. These would be moving with various velocities, depending on the original motion of the body they came from and the direction in which they were shot away, but a large proportion would be moving very slowly, and would be drawn into orbits passing very near the sun. The concentration of such orbits near him in the course of time is inevitable. If bodies approaching him from all parts of space are a thousand miles apart when they come within the distance of Neptune, they will be only one mile apart if they approach within six times the length of the sun's radius.

The bodies thus met with in the sun's path would generally, for long periods of time, be moving in the same direction, because they would come from the same source.

The stars are separated by and moving through such immense distances, that each one has a vast field of space in which its own operations are scarcely interfered with by any other, and as the smoke of an ocean steamer spreads far over the sea before it mixes with the smoke of any other vessel, so the matter ejected from any one of the stars would be generally found unmixed in the spaces it travelled through.

In any course the sun may take through space sprinkled

with matter in this form, a great number of the small bodies drawn towards him will probably be drawn into orbits nearly in the same plane, and if the zodiacal light is really caused, as most astronomers imagine, by a cloud of revolving meteors, it is just such a cloud as might thus be expected to surround him.

As it barely extends as far as the earth's orbit, and is not in the plane of the ecliptic, the great bulk of meteoric matter gathered by the sun would be entirely out of our reach, and would be enormously in excess of any estimates founded on the number of meteors encountered by the earth; and the more these bodies are collected in groups instead of being uniformly distributed, the fewer of them will be encountered; just as it is infinitely easier to hit a flying bird with an ounce of small shot than with a hundred-pound cannon ball. Suppose you have a round target, sixty yards in diameter, and you draw a black line round its circumference a tenth of an inch wide; that line will represent the comparative width of the earth's path in her orbit. Let a very small pea move continually round this orbit, and let a regiment of soldiers keep firing at the target. The number of bullets that will hit the pea will give some idea of the proportion of meteor groups passing through the solar system the earth is ever likely to encounter.

It seems clear, therefore, that the quantity of matter required to maintain the sun's heat may readily be supplied without that bombardment of the earth which has been supposed to be a necessary consequence.

A constant supply of fresh matter in this way would, however, involve a constant increase in the size of the sun; but a constant decrease in his size is the result of the contraction theory, and the rate of decrease is much more rapid than the rate of increase would need to be.

The estimated contraction of the sun's diameter, on the

Nebular Theory, is four miles in a century. The estimated addition of matter equal to the earth's mass in a century would increase the sun's diameter by only five hundred yards at the earth's density, or little over one mile at the assumed density of the sun. There might, in fact, be no addition, for if volcanic action disperses matter into space from the stars, it probably does so from the sun, and he may in this way return as much as he receives; or, if this is inconsistent with the general equivalence of forces, he may at least return a part of it, for chemical as well as mechanical force would be brought by the new material. For either case the general rate of change would be much slower than on the nebular theory, and the limits of geological time would be extended in proportion.

If we take a broad view of cosmical arrangements under this theory, we shall see the great bodies of space travelling through it at vast distances from each other, each of them scattering materials out of his own substance, and in the meantime feeding upon the materials scattered by his next neighbours, and glowing with the heat of their continued impact upon his own atmosphere—an atmosphere necessarily dense, from the size of the attracting mass.

It will not follow that the bodies themselves within this atmosphere are at a high temperature, for if the heat is generated in the upper part of the atmosphere, and has to descend, it will be rapidly carried up again by convection currents, and so radiated chiefly into outer space. The supply of materials may vary from age to age, and with it the radiated heat will also vary, and epochs of extreme warmth or cold in the planets dependent on these glowing suns may attend these changes. The general tendency of the large bodies meanwhile is to grow larger, but as they do so their mutual attractions are increased and their paths are altered. Sooner or later they come into collision with

each other. A new sun, moving in a new path, is formed; great fragments are shattered off and hurled away, to become, perhaps, the planets of a new system. At the moment of contact there is a prodigious flash of heat and conversion of solid matter into glowing gas, which, however, will cool perhaps to its former state in a few years. All the phenomena of variable and of new stars are in accordance with these views. Continued change, reproducing systems of the same kind, but with altered arrangements, will be the general law. We have only to add to this the strictly philosophical belief that the heat radiated into space cannot be really lost, but must be retained as energy in some other form, possibly in the form of the cause of gravitation,* to make the duration of a moving and living universe practically without limit both in the future and in the past.

The Nebular Theory begins with a universe of gas, and ends with one of burnt-out matter, its light and heat travelling away from its cold ashes in ethereal waves, without purpose or consequence, for ever. It is not a cheerful thing to contemplate, and I hope I have shown sufficient grounds for asserting, not only that we are not bound to it by any scientific considerations, but that it ought now to be abandoned as a speculation which, however attractive to many minds, is inconsistent with what we really know.

* I do not mean to imply a belief that gravity can be caused by pressure in any form. Till the contrary is really proved it must be assumed that no *pushing* force can, by itself, account for what we now know as universal attraction.

EIRIK THE RED'S SAGA.

By the REV. J. SEFTON.

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[Olaf, who was called Olaf the White, was styled a warrior king. He was the son of King Ingjald, the son of Helgi, the son of Olaf, the son of Gudred, the son of Halfdan Whiteleg, king of the Uplands (in Norway). He led a harrying expedition of sea-rovers into the west, and conquered Dublin, in Ireland, and Dublinshire, over which he made himself king. He married Aud the Deep-minded, daughter of Ketil Flatnose, son of Bjorn the Ungartered, a noble man from Norway. Their son was named Thorstein the Red. Olaf fell in battle in Ireland, and then Aud and Thorstein went into the Sudreyjar (the Hebrides). There Thorstein married Thorid, daughter of Eyvind the Easterling, sister of Helgi the Lean; and they had many children. Thorstein became a warrior king, and formed an alliance with Earl Sigurd the Great, son of Eystein the Rattler. They conquered Caithness, Sutherland, Ross, and Moray,

and more than half Scotland. Over these Thorstein was king until the Scots plotted against him, and he fell there in battle. Aud was in Caithness when she heard of Thorstein's death. Then she caused a merchant-ship to be secretly built in the wood, and when she was ready, directed her course out into the Orkneys. There she gave in marriage Thorstein the Red's daughter, Gro, who became mother of Grelad, whom Earl Thorfinn, the Skullcleaver, married. Afterwards Aud set out to seek Iceland, having twenty free men in her ship. Aud came to Iceland, and passed the first winter in Bjarnarhofn (Bjornshaven) with her brother Bjorn. Afterwards she occupied all the Dale country between the Dogurdara (day-meal river) and the Skraumuhlaupsa (river of the giantess's leap), and dwelt at Hvamm. She had prayer meetings at Krossholar (Crosshills), where she caused crosses to be erected, for she was baptised and deeply devoted to the faith. There came with her to Iceland many men worthy of honour, who had been taken captive in sea-roving expeditions to the west, and who were called bondmen. One of these was named Vifil; he was a man of high family, and had been taken captive beyond the western main, and was also called a bondman before Aud set him free. And when Aud granted dwellings to her ship's company, Vifil asked why she gave no abode to him like unto the others. Aud replied, "That it was of no moment to him, for," she said, "he would be esteemed in whatever place he was, as one worthy of honour." She gave him Vifilsdalr (Vifilsdale), and he dwelt there and married. His sons were Thorbjorn and Thorgeir, promising men, and they grew up in their father's house.

2. There was a man named Thorvald, the son of Asvald, the son of Ulf, the son of Yxna-Thoris. His son was named Eirik. Father and son removed from Jadar (in Norway) to Iceland, because of manslaughters, and occupied land in Hornstrandir, and dwelt at Drangar. There Thorvald

died, and Eirik then married Thjodhild, daughter of Jorund, the son of Atli, and of Thorbjorg the Ship-breasted, whom afterwards Thorbjorn, of the Haukadalr (Hawkdale) family, married; he it was who dwelt at Eiriksstadr after Eirik removed from the north. It is near Vatzhorn. Then did Eirik's thralls cause a landslip on the estate of Valthjof, at Valthjofsstadr. Eyjolf the Foul, his kinsman, slew the thralls beside Skeidsbrekkur (slopes of the race-course), above Vatzhorn. In return Eirik slew Eyjolf the Foul; he slew also Hrafn the Dueller, at Leikskalar (playbooths). Gerstein, and Odd of Jorfi, kinsman of Eyjolf, were found willing to follow up his death by a legal prosecution; and then was Eirik banished from Haukadalr. He occupied then Brokey and Eyxney, and dwelt at Tradir, in Sudrey, the first winter. At this time did he lend to Thorgest pillars for seat-stocks. Afterwards Eirik removed into Eyxney, and dwelt at Eiriksstadr. He then claimed his pillars, and got them not. Then went Eirik and fetched the pillars from Breidabolstadr, and Thorgest went after him. They fought at a short distance from the hay-yard at Drangar, and there fell two sons of Thorgest, and some other men. After that they both kept a large body of men together. Styr gave assistance to Eirik, as also did Eyjolf, of Sviney, Thorbjorn Vifilsson, and the sons of Thorbrand, of Alptafjordr (Swanfirth). But the sons of Thord Gellir, as also Thorgeir, of Hitardalr (Hotdale), Aslak, of Langadalr (Longdale), and Illugi, his son, gave assistance to Thorgest. Eirik and his people were outlawed at Thorsnes Thing. He prepared a ship in Eiriksvagr (creek), and Eyjolf concealed him in Dimunarvagr while Thorgest and his people sought him among the islands. Eirik said to his people that he purposed to seek for the land which Gunnbjorn, the son of Ulf the Crow, saw when he was driven westwards over the ocean, and discovered Gunnbjarnarsker (Gunnbjorn's rock or skerry). He promised that he would return to visit his

friends if he found the land. Thorbjorn, and Eyjolf, and Styr accompanied Eirik beyond the islands. They separated in the most friendly manner, Eirik saying that he would be of the like assistance to them, if he should be able so to be, and they should happen to need him. Then he sailed oceanwards under Snœfellsjokull (snow mountain glacier), and arrived at the glacier called Blaserkr (Blue-shirt); thence he journeyed south to see if there were any inhabitants of the country. He passed the first winter at Eiriksey, near the middle of the Vestribygd (western settlement). The following spring he proceeded to Eiriksfjordr, and fixed his abode there. During the summer he proceeded into the unpeopled districts in the west, and was there a long time, giving names to the places far and wide. The second winter he passed in Eiriksholmar (isles), off Hvarfsgnupr (peak of disappearance, Cape Farewell); and the third summer he went altogether northwards, to Snœfell and into Hrafnsfjordr (Ravensfirth); considering then that he had come to the head of Eiriksfjordr, he turned back, and passed the third winter in Eiriksey, before the mouth of Eiriksfjordr. Now, afterwards, during the summer, he proceeded to Iceland, and came to Breidafjordr (Broadfirth). This winter he was with Ingolf, at Holmlatr (Island-litter). During the spring, Thorgest and he fought, and Eirik met with defeat. After that they were reconciled. In the summer Eirik went to live in the land which he had discovered, and which he called Greenland, "Because," said he, "men will desire much the more to go there if the land has a good name."]

8. Thorgeir Vifilsson married, and took to wife Arnora, daughter of Einar, from Laugarbrekka (the slope of the hot spring), the son of Sigmund, the son of Ketil-Thistil, who had occupied Thistilsfjordr. The second daughter of Einar was named Hallveig. Thorbjorn Vifilsson took her to wife, and received with her the land of Laugarbrekka, at Hellisvollr (the cave-hill). To that spot Thorbjorn removed his

abode, and became great and worshipful. He was the temple-priest, and had a magnificent estate. Thorbjorn's daughter was Gudrid, the fairest of women, and of peerless nobility in all her conduct. There was a man named Orm, who dwelt at Arnarstapi (eagle-rock), and he had a wife who was named Halldis. He was a well-to-do franklin, a great friend of Thorbjorn, and Gudrid lived at his house as his foster-child for a long time. There was a man named Thorgeir, who dwelt at Thorgeirsfjall (fell). He was mighty rich in cattle, and had been made a freedman. He had a son, whose name was Einar, a handsome man, well mannered, and a great dandy. Einar, at this time, was a travelling merchant, sailing from land to land with great success; and he always passed his winter either in Iceland or in Norway. Now after this, I have to tell how that one autumn, when Einar was in Iceland, he proceeded with his wares along Snœfellsnes, with the object of selling; he came to Arnarstapi; Orm invited him to stay there, and Einar accepted his invitation, because there was friendship between him and Orm's people, and his wares were carried into a certain outhouse. There he unpacked his merchandise, showed it to Orm and the housemen, and bade Orm take therefrom such things as he would. Orm accepted the offer, and pronounced Einar to be a goodly gallant traveller, and a great favourite of fortune. When now they were busy with the wares, a woman passed before the door of the outhouse; and Einar inquired of Orm who that fair woman might be, passing before the door. "I have not seen her here before," said he. "That is Gudrid, my foster-child," said Orm, "daughter of Thorbjorn the franklin, from Laugarbrekka." "She must be a good match," said Einar; "surely she has not been without suitors who have made proposals for her, has she?" Orm answered, "Proposals have certainly been made, friend, but this treasure is not to be had for the picking up; it is found that she will be particular in her choice, as well as also her

father." "Well, in spite of that," quoth Einar, "she is the woman whom I have it in my mind to propose for, and I wish that in this suit of mine you approach her father on my part, and apply yourself to plead diligently* for me, for which I shall pay you in return a perfect friendship. The franklin, Thorbjorn, may reflect that our families would be suitably joined in the bonds of affinity; for he is a man in a position of great honour, and owns a fine abode, but his personal property, I am told, is greatly on the decrease; neither I nor my father lack lands or personal property; and if this alliance should be brought about, the greatest assistance would accrue to Thorbjorn." Then answered Orm, "Of a surety I consider myself to be thy friend, and yet am I not willing to bring forward this suit, for Thorbjorn is of a proud mind, and withal a very ambitious man." Einar replied that he desired no other thing than that his offer of marriage should be made known. Orm then consented to undertake his suit, and Einar journeyed south again until he came home. A while after, Thorbjorn had a harvest-feast, as he was bound to have because of his great rank. There were present Orm, from Arnarstapi, and many other friends of Thorbjorn. Orm entered into conversation with Thorbjorn, and told him how that Einar had lately been to see him from Thorgeirsfjall, and was become a promising man. He now began the wooing on behalf of Einar, and said that an alliance between the families would be very suitable on account of certain interests. "There may arise to thee, franklin," he said, "great assistance in thy means from this alliance." But Thorbjorn answered, "I did not expect the like proposal from thee, that I should give my daughter in marriage to the son of a thrall. And so thou perceivest that my substance is decreasing; well, then, my daughter shall not go home with thee, since thou considerest her worthy of

* The word "alendu" is a difficulty. Perhaps we ought to read "allidnu," or "allidinu."

so poor a match." Then went Orm home again, and each of the other guests to his own household, and Gudrid remained with her father, and stayed at home that winter.

Now, in the spring, Thorbjorn made a feast to his friends, and a goodly banquet was prepared. There came many guests, and the banquet was of the best. Now, at the banquet, Thorbjorn called for a hearing, and thus spake :— "Here have I dwelt a long time. I have experienced the goodwill of men and their affection towards me, and I consider that our dealings with one another have been mutually agreeable. But now do my money matters begin to bring me uneasiness, although to this time my condition has not been reckoned contemptible. I wish, therefore, to break up my household before I lose my honour; to remove from the country before I disgrace my family. So now I purpose to look after the promises of Eirik the Red, my friend, which he made when we separated at Breidafjordr. I purpose to depart for Greenland in the summer, if events proceed as I could wish." These tidings about this design appeared to the guests to be important, for Thorbjorn had long been beloved by his friends. They felt that he would only have made so public a declaration that it might be held of no avail to attempt to dissuade him from his purpose. Thorbjorn distributed gifts among the guests, and then the feast was brought to an end, and they departed to their own homesteads. Thorbjorn sold his lands, and bought a ship which had been laid up on shore at the mouth of the Hraunhofn (harbour of the lava field). Thirty men ventured on the expedition with him. There was Orm, from Arnarstapi, and his wife, and those friends of Thorbjorn who did not wish to be separated from him. Then they launched the ship, and set sail with a favourable wind. But when they came out into the open sea the favourable wind ceased, and they experienced great gales, and made but an ill-sped

voyage throughout the summer. In addition to that trouble, there came fever upon the expedition, and Orm died, and Halldis, his wife, and half the company. Then the sea waxed rougher, and they endured much toil and misery in many ways, and only reached Herjolfsnes, in Greenland, at the very beginning of winter. There dwelt at Herjolfsnes the man who was called Thorkell. He was a useful man and most worthy franklin. He received Thorbjorn and all his ship's company for the winter, assisting them in right noble fashion. This pleased Thorbjorn well and his companions in the voyage.

At that time there was a great dearth in Greenland; those who had been out on fishing expeditions had caught little, and some had not returned. There was in the settlement the woman whose name was Thorbjorg. She was a prophetess (spae-queen), and was called Litilvolva (little sybil). She had had nine sisters, and they were all spae-queens, and she was the only one now living. It was a custom of Thorbjorg, in the winter time, to make a circuit, and people invited her to their houses, especially those who had any curiosity about the season, or desired to know their fate; and inasmuch as Thorkell was chief franklin thereabouts, he considered that it concerned him to know when the scarcity which overhung the settlement should cease. He invited, therefore, the spae-queen to his house, and prepared for her a hearty welcome, as was the custom wherever a reception was accorded a woman of this kind. A high seat was prepared for her, and a cushion laid thereon in which were poultry-feathers. Now, when she came in the evening, accompanied by the man who had been sent to meet her, she was dressed in such wise that she had a blue mantle over her, with strings for the neck, and it was inlaid with gems quite down to the skirt. On her neck she had glass beads. On her head she had a black hood of lambskin, lined

with ermine. A staff she had in her hand, with a knob thereon; it was ornamented with brass, and inlaid with gems round about the knob. Around her she wore a girdle of soft hair, and therein was a large skin-bag, in which she kept the talismans needful to her in her wisdom. She wore hairy calf-skin shoes on her feet, with long and strong-looking thongs to them, and great knobs of latten at the ends. On her hands she had gloves of ermine-skin, and they were white and hairy within. Now, when she entered, all men thought it their bounden duty to offer her becoming greetings, and these she received according as the men were agreeable to her. The franklin Thorkell took the wise-woman by the hand, and led her to the seat prepared for her. He requested her to cast her eyes over his herd, his household, and his homestead. She remained silent altogether. During the evening the tables were set; and now I must tell you what food was made ready for the spae-queen. There was prepared for her porridge of kid's milk, and hearts of all kinds of living creatures there found were cooked for her. She had a brazen spoon, and a knife with a handle of walrus-tusk, which was mounted with two rings of brass, and the point of it was broken off. When the tables were removed, the franklin Thorkell advanced to Thorbjorg and asked her how she liked his homestead, or the appearance of the men; or how soon she would ascertain that which he had asked, and which the men desired to know. She replied that she would not give answer before the morning, after she had slept there for the night. And when the (next) day was far spent, the preparations were made for her which she required for the exercise of her enchantments. She begged them to bring to her those women who were acquainted with the lore needed for the exercise of the enchantments, and which is known by the name of Weird-songs, but no such women came forward. Then was search made throughout the homestead if any

woman were so learned. Then answered Gudrid, "I am not skilled in deep learning, nor am I a wise-woman, although Halldis, my foster-mother, taught me, in Iceland, the lore which she called Weird-songs." "Then art thou wise in good season," answered Thorbjorg; but Gudrid replied, "That lore and the ceremony are of such a kind, that I purpose to be of no assistance therein, because I am a Christian woman." Then answered Thorbjorg, "Thou mightest perchance afford thy help to the men in this company, and yet be none the worse woman than thou wast before; but to Thorkell give I charge to provide here the things that are needful." Thorkell thereupon urged Gudrid to consent, and she yielded to his wishes. The women formed a ring round about, and Thorbjorg ascended the scaffold and the seat prepared for her enchantments. Then sang Gudrid the weird-song in so beautiful and excellent a manner, that to no one there did it seem that he had ever before heard the song in voice so beautiful as now. The spae-queen thanked her for the song. "Many spirits," said she, "have been present under its charm, and were pleased to listen to the song, who before would turn away from us, and grant us no such homage. And now are many things clear to me which before were hidden both from me and others. And I am able this to say, that the dearth will last no longer—the season improving as spring advances. The epidemic of fever which has long oppressed us will disappear quicker than we could have hoped. And thee, Gudrid, will I recompense straightway, for that aid of thine which has stood us in good stead; because thy destiny is now clear to me, and foreseen. Thou shalt make a match here in Greenland, a most honourable one, though it will not be a long-lived one for thee, because thy way lies out to Iceland; and there, shall arise from thee a line of descendants both numerous and goodly, and over the branches of

thy family shall shine a bright ray. And so fare thee now well and happily, my daughter." Afterwards the men went to the wise-woman, and each enquired after what he was most curious to know. She was also liberal of her replies, and what she said proved true. After this came one from another homestead after her, and she then went there. Thorbjorn was invited, because he did not wish to remain at home while such heathen worship was performing. The weather soon improved when once spring began, as Thorbjorg had said. Thorbjorn made ready his ship, and went on until he came to Brattahlid (the steep slope). Eirik received him with the utmost cordiality, saying he had done well to come there. Thorbjorn and his family were with him during the winter. And in the following spring Eirik gave to Thorbjorn land at Stokknes, and handsome farm buildings were there built for him, and he dwelt there afterwards.

4. Eirik had a wife who was named Thjodhild, and two sons; the one was named Thorstein, and the other Leif. These sons of Eirik were both promising men. Thorstein was then at home with his father; and there was at that time no man in Greenland who was thought so highly of as he. Leif had sailed to Norway, and was there with King Olaf Tryggvason. Now, when Leif sailed from Greenland during the summer, he and his men were driven out of their course to the Sudreyjar. They were slow in getting a favourable wind from this place, and they stayed there a long time during the summer . . . . . reaching Norway about harvest-tide. He joined the body-guard of King Olaf Tryggvason, and the king formed an excellent opinion of him, and it appeared to him that Leif was a well-bred man. Once upon a time the king entered into conversation with Leif, and asked him, "Dost thou purpose sailing to Greenland in summer?" Leif answered, "I should wish so to do, if it is your will." The king replied, "I think it may

well be so; thou shalt go my errand, and preach Christianity in Greenland." Leif said that he was willing to undertake it, but that, for himself, he considered that message a difficult one to proclaim in Greenland. But the king said that he knew no man who was better fitted for the work than he. "And thou shalt carry," said he, "good luck with thee in it." "That can only be," said Leif, "if I carry yours with me." Leif set sail as soon as he was ready. He was tossed about a long time out at sea, and lighted upon lands of which before he had no expectation. There were fields of wild wheat, and the vine-tree in full growth. There were also the trees which were called maples; and they gathered of all this certain tokens; some trunks so large that they were used in house-building. Leif came upon men who had been shipwrecked, and took them home with him, and gave them sustenance during the winter. Thus did he show his great munificence and his graciousness when he brought Christianity to the land, and saved the shipwrecked crew. He was called Leif the Lucky. Leif reached land in Eiriksfjordr, and proceeded home to Brattahlid. The people received him gladly. He soon after preached Christianity and catholic truth throughout the land, making known to the people the message of King Olaf Tryggvason; and declaring how many renowned deeds and what great glory accompanied this faith. Eirik took coldly to the proposal to forsake his religion, but his wife, Thjodhild, promptly yielded, and caused a church to be built not very near the houses. The building was called Thjodhild's Church; in that spot she offered her prayers, and so did those men who received Christ, and they were many. After she accepted the faith, Thjodhild would have no intercourse with Eirik, and this was a great trial to his temper.

After this there was much talk about making ready to go to the land which Leif had discovered. Thorstein, Eirik's

son, was chief mover in this, a worthy man, wise and much liked. Eirik was also asked to go, and they believed that his luck and foresight would be of the highest use. He was [for a long time against it, but did not say nay], when his friends exhorted him to go. They made ready the ship which Thorbjorn had brought there, and there were twenty men who undertook to start in her. They had little property, but chiefly weapons and food. On the morning when Eirik left home he took a little box, which had in it gold and silver; he hid the money, and then went forth on his journey. He had proceeded, however, but a little way, when he fell from his horse, and broke his ribs and injured his shoulder, and cried out, "Aiai!" At this accident he sent word to his wife that she should take away the money that he had hidden, declaring his misfortune to be a penalty paid on account of having hid the money. Afterwards they sailed away out of Eiriksfjordr with gladness, as their plan seemed to promise success. They were driven about for a long time on the open sea, and came not into the track which they desired. They came in sight of Iceland, and also met with birds from the coast of Ireland. Then was their ship tossed to and fro on the sea. They returned about harvest-tide, worn out by toil and much exhausted, and reached Eiriksfjordr at the beginning of winter. Then spake Eirik, "You were in better spirits in the summer, when you went forth out of the firth, than you are in now, and yet for all that there is much to be thankful for." Thorstein replied, "It is a chieftain's duty now to look after some arrangement for these men who are without shelter, and to find them food." Eirik answered, "That is an ever-true saying, 'You know not until you have got your answer.' I will now take thy counsel about this." All those who had no other abodes were to go with the father and the son. Then came they to land, and went forth home.

5. Now, after this, I have to tell you how Thorstein, Eirik's son, began wooing Gudrid, Thorbjorn's daughter. To his proposals a favourable answer was given, both by the maid herself, and also by her father. The marriage was also arranged, so that Thorstein went to take possession of his bride, and the bridal feast was held at Brattahlid in the autumn. The banquet went off well, and was numerously attended. Thorstein owned a homestead in the Vestribygd on the estate known as Lysufjordr (shining firth). The man who was called Thorstein owned the other half of the homestead. His wife was called Sigrid. Thorstein went, during the autumn, to Lysufjordr, to his namesake, both he and Gudrid. Their reception was a welcome one. They were there during the winter. When little of the winter was past, the event happened there that fever broke out on their estate. The overseer of the work was named Garth. He was an unpopular man. He took the fever first and died. Afterwards, and with but little intermission, one took the fever after another and died. Then Thorstein, Eirik's son, fell ill, and also Sigrid, the wife of his namesake Thorstein. [And one evening Sigrid left the house, and rested awhile opposite the outer door; and Gudrid accompanied her; and they looked back towards the outer door, and Sigrid screamed out aloud. Gudrid said, "We have come forth unwarily, and thou canst in no wise withstand the cold; let us even go home as quickly as possible." "It is not safe as matters are," answered Sigrid. "There is all that crowd of dead people before the door; Thorstein, thy husband, also, and myself, I recognise among them, and it is a grief thus to behold." And when this passed away, she said, "Let us now go, Gudrid; I see the crowd no longer." Thorstein, Eirik's son, had also disappeared from her sight; he had seemed to have a whip in his hand, and to wish to smite the ghostly troop. Afterwards

they went in, and before morning came she was dead, and a coffin was prepared for the body. Now, the same day, the men purposed to go out fishing, and Thorstein led them to the landing places, and in the early morning he went to see what they had caught. Then Thorstein, Eirik's son, sent word to his namesake to come to him, saying that matters at home were hardly quiet; that the housewife was endeavouring to rise to her feet and to get under the clothes beside him. And when he was come in she had risen upon the edge of the bed. Then took he her by the hands and laid a pole-axe upon her breast. Thorstein, Eirik's son, died near nightfall. Thorstein, the franklin, begged Gudrid to lie down and sleep, saying that he would watch over the body during the night. So she did, and when a little of the night was past, Thorstein, Eirik's son, sat up and spake, saying he wished Gudrid to be called to him, and that he wished to speak with her. "God wills," he said, "that this hour be given to me for my own, and the further completion of my plan." Thorstein, the franklin, went to find Gudrid, and waked her; begged her to cross herself, and to ask God for help, and told her what Thorstein, Eirik's son, had spoken with him; "and he wishes," said he, "to meet with thee. Thou art obliged to consider what plan thou wilt adopt, because I can in this issue advise thee in nowise." She answered, "It may be that this, this wonderful thing, has regard to certain matters which are afterwards to be had in memory; and I hope that God's keeping will rest upon me, and I will, with God's grace, undertake the risk and go to him, and know what he will say, for I shall not be able to escape if harm must happen to me. I am far from wishing that he should go elsewhere; I suspect, moreover, that the matter will be a pressing one." Then went Gudrid and saw Thorstein. He appeared to her as if shedding tears. He spake in her ear, in a low voice, certain words which she

alone might know; but this he said so that all heard, "That those men would be blessed who held the true faith, and that all salvation and mercy accompanied it; and that many, nevertheless, held it lightly." "It is," said he, "no good custom which has prevailed here in Greenland since Christianity came, to bury men in unconsecrated ground with few religious rites over them. I wish for myself, and for those other men who have died, to be taken to the church; but for Garth, I wish him to be burned on a funeral pile as soon as may be, for he is the cause of all those ghosts which have been among us this winter." He spake to Gudrid also about her own state, saying that her destiny would be a great one, and begged her to beware of marrying Greenland men. He begged her also to pay over their property to the Church and some to the poor; and then he sank down for the second time.] It had been a custom in Greenland, after Christianity was brought there, to bury men in unconsecrated ground on the farms where they died. An upright stake was placed over a body, and when the priests came afterwards to the place, then was the stake pulled out, consecrated water poured therein, and a funeral service held, though it might be long after the burial. The bodies were removed to the church in Eiriksfjordr, and funeral services held by the priests. After that died Thorbjorn. The whole property then went to Gudrid. Eirik received her into his household, and looked well after her stores.

6. There was a man named Thorfinn Karlsefni, son of Thord Horsehead, who dwelt in the north (of Iceland), at Reynines in Skagafjordr, as it is now called. Karlsefni was a man of good family, and very rich. His mother's name was Thorun. He engaged in trading journeys, and seemed a goodly, bold, and gallant traveller. One summer Karlsefni prepared his ship, intending to go to Greenland. Snorri, Thorbrand's son, from Alptafjordr, resolved to travel with

him, and there were thirty men in the company. There was a man named Bjarni, Grimolf's son, a man of Breidafjordr (Broadfirth); another called Thorhall, son of Gamli, a man from the east of Iceland. They prepared their ship the very same summer as Karlsefni, with intent also to go to Greenland. They had in the ship forty men. The two ships launched out into the open sea as soon as they were ready. It is not recorded how long a voyage they had. But, after this, I have to tell you that both these ships came to Eiriksfjordr about autumn. Eirik rode down to the ships with other men of the land, and a market-fair was promptly instituted. The captains invited Gudrid to take such of the merchandise as she wished, and Eirik displayed on his part much magnificence in return, inasmuch as he invited both these ships' companies home with him to pass the winter in Brattahlid. The merchants accepted the invitation, and went home with Eirik. Afterwards their merchandise was removed to Brattahlid, where a good and large outhouse was not lacking in which to store the goods. The merchants were well pleased to stay with Eirik during the winter. When now Yule was drawing nigh, Eirik began to look more gloomy than he was wont to be. Presently Karlsefni entered into conversation with him, and said, "Art thou in trouble, Eirik? it appears to me that thou art somewhat more taciturn than thou hast been; still thou helpest us with much liberality, and we are bound to reward thee according as we have means thereto. Say now what causes thy cheerlessness." Eirik answered, "You receive hospitality well, and like worthy men. Now, I have no mind that our intercourse together should be expensive to you; but so it is, that it will seem to me an ill thing if it is heard that you never spent a worse Yule than this, just now beginning, when Eirik the Red entertained you at Brattahlid, in Greenland." Karlsefni answered, "It must not come to such a pass; we have

in our ships malt, meal, and corn, and you have right and title to take therefrom whatever you wish, and to make your entertainment such as consorts with your munificence." And Eirik accepted the offer. Then was preparation made for the Yule-feast, and so magnificent was it that the men thought they had scarcely ever seen so grand a feast. And after Yule, Karlsefni broached to Eirik the subject of a marriage with Gudrid, which he thought might be under Eirik's control, and the woman appeared to him to be both beautiful and of excellent understanding. Eirik answered and said, that for his part he would willingly undertake his suit, and said, moreover, that she was worthy of a good match. It is also likely, he thought, that she will be following out her destiny, should she be given to him; and, moreover, the report which comes to me of him is good. The proposals were now laid before her, and she allowed the marriage with her to be arranged which Eirik wished to promote. However, I will not now speak at length how this marriage took place; the Yule festival was prolonged and made into a marriage-feast. Great joy was there in Brattahlid during the winter. Much playing at backgammon and telling of stories went on, and many things were done that ministered to the comfort of the household.

7. During this time much talk took place in Brattahlid about making ready to go to Vinland the Good, and it was asserted that they would there find good choice lands. The discourse came to such conclusion that Karlsefni and Snorri prepared their ship, with the intention of seeking Vinland during the summer. Bjarni and Thorhall ventured on the same expedition, with their ship and the retinue which had accompanied them. [There was a man named Thorvard; he married Freydis, natural daughter of Eirik the Red; he set out with them likewise, as also Thorvald, a son of Eirik.]

There was a man named Thorvald; he was a son-in-law * of Eirik the Red. Thorhall was called the Sportsman; he had for a long time been Eirik's companion in hunting and fishing expeditions during the summers, and many things had been committed to his keeping. Thorhall was a big man, dark, and of gaunt appearance; rather advanced in years, overbearing in temper, of melancholy mood, silent at all times, underhand in his dealings, and withal given to abuse, and always inclined towards the worst. He had kept himself aloof from the true faith when it came to Greenland. He was but little encompassed with the love of friends, but yet Eirik had long held conversation with him. He went in the ship with Thorvald and his men, because he was widely acquainted with the unpeopled districts. They had the ship which Thorbjorn had brought to Greenland, and they ventured on the expedition with Karlsefni and the others; and most of them in this ship were Greenlanders. There were one hundred and sixty men in their ships. They sailed away from land; then to the Vestribygd and to Bjarneyjar (the Bear Islands). Thence they sailed away from Bjarneyjar with northerly winds. They were out at sea two half-days. Then they came to land, and rowed along it in boats, and explored it, and found there flat stones, many and so great that two men might well lie on them stretched on their backs with heel to heel. Polar-foxes were there in abundance. This land they gave name to, and called it Helluland (stone-land). Then they sailed with northerly winds two half-days, and there was then land before them, and on it a great forest and many wild beasts. An island lay in the south-east off the land, and they found bears thereon, and called the island Bjarney (Bear Island);

* Later on in the Saga he is called a son of Eirik. The text would appear to be somewhat corrupt here, as the passage in square brackets from Hauks-bok seems to show.

but the mainland, where the forest was, they called Markland (forest-land). Then, when two half-days were passed, they saw land, and sailed under it. There was a cape to which they came. They cruised along the land, leaving it on the starboard side. There was a harbourless coast-land, and long sandy strands. They went to the land in boats, and found the keel of a ship, and called the place Kjalar-nes (Keelness). They gave also name to the strands, calling them Furdu-strandir (wonder-shore), because it was tedious to sail by them. Then the coast became indented with creeks, and they directed their ships along the creeks. Now, before this, when Leif was with King Olaf Tryggvason, and the king had requested him to preach Christianity in Greenland, he gave him two Scotch people, the man called Haki, and the woman called Hækja. The king requested Leif to have recourse to these people if ever he should want fleetness, because they were swifter than wild beasts. Eirik and Leif had got these people to go with Karlsefni. Now, when they had sailed by Furdu-strandir, they put the Scotch people on land, and requested them to run into the southern regions, seek for choice land, and come back after three half-days* were passed. They were dressed in such wise that they had on the garment which they called *biafal*. It was made with a hood at the top, open at the sides, without sleeves, and was fastened between the legs. A button and a loop held it together there; and elsewhere they were without clothing. Then did they cast anchors from the ships, and lay there to wait for them. And when three days were expired the Scotch people leapt down from the land, and one of them had in his hand a bunch of grapes, and the other an ear of wild wheat.

* The word "dœgr," both here and above, is translated "half-day," though it may possibly mean a period of twenty-four hours. It is to be noticed, however, that these Scotch people return after three "dagar," which can only mean periods of twenty-four hours.

They said to Karlsefni that they considered they had found good and choice land. Then they received them into their ship, and proceeded on their journey to where the shore was cut into by a firth. They directed the ships within the firth. There was an island lying out in front of the firth, and there were great currents around the island, which they called Straums-ey (Stream-island). There were so many birds on it that scarcely was it possible to put one's feet down for the eggs. They continued their course up the firth, which they called Straumsfjordr, and carried their cargo ashore from the ships, and there they prepared to stay. They had with them cattle of all kinds, and for themselves they sought out the produce of the land thereabout. There were mountains, and the place was fair to look upon. They gave no heed to anything except to explore the land, and they found large pastures. They remained there during the winter, which happened to be a hard one, with no work doing; and they were badly off for food, and the fishing failed. Then they went out to the island, hoping that something might be got there from fishing or from what was drifted ashore. In that spot there was little, however, to be got for food, but their cattle found good sustenance. After that they called upon God, praying that He would send them some little store of meat, but their prayer was not so soon granted as they were eager that it should be: Thorhall disappeared from sight, and they went to seek him, and sought for three half-days continuously. On the fourth half-day Karlsefni and Bjarni found him on the peak of a crag. He lay with his face to the sky, with both eyes and mouth and nostrils wide open, clawing and pinching himself, and reciting something. They asked why he had come there. He replied that it was of no importance; begged them not to wonder thereat; as for himself, he had lived so long, they needed not to take any account of

him. They begged him to go home with them, and he did so. A little while after a whale was driven ashore, and the men crowded round it, and cut it up, and still they knew not what kind of whale it was. Even Karlsefni recognised it not, though he had great knowledge of whales. It was cooked by the cook-boys, and they ate thereof; though bad effects came upon all from it afterwards. Then began Thorhall, and said, "Has it not been that the Redbeard has proved a better friend than your Christ? this was my gift for the poetry which I composed about Thor, my patron; seldom has he failed me." Now, when the men knew that, none of them would eat of it, and they threw it down from the rocks, and turned with their supplications to God's mercy. Then was granted to them opportunity of fishing, and after that there was no lack of food that spring. They went back again from the island, within Straumsfjordr, and obtained food from both sides; from hunting on the mainland, and from gathering eggs and from fishing on the side of the sea.

8. When summer was at hand they discussed about their journey, and made an arrangement. Thorhall the Sportsman wished to proceed northwards along Furdustrandir, and off Kjalarnes, and so seek Vinland; but Karlsefni desired to proceed southwards along the land and away from the east, because the land appeared to him the better the further south he went, and he thought it also more advisable to explore in both directions. Then did Thorhall make ready for his journey out by the islands, and there volunteered for the expedition with him not more than nine men; but with Karlsefni there went the remainder of the company. And one day, when Thorhall was carrying water to his ship, he drank, and recited this verse:—

"The clashers of weapons did say when I came here that I should have the best of drink (though it becomes me not to complain before the common people). Eager God of the

war-helmet! I am made to raise the bucket; wine has not moistened my beard, rather do I kneel at the fountain."

Afterwards they put to sea, and Karlsefni accompanied them by the island. Before they hoisted sail Thorhall recited a verse:—

"Go we back where our countrymen are. Let us make the skilled hawk of the sand-heaven explore the broad ship-courses; while the dauntless rousers of the sword-storm, who praise the land, and cook whale, dwell on Furdustrandir."

Then they left, and sailed northwards along Furdustrandir and Kjalarnes, and attempted there to sail against a wind from the west. A gale came upon them, however, and drave them onwards against Ireland, and there were they severely treated, enthralled, and beaten. Then Thorhall lost his life.

9. Karlsefni proceeded southwards along the land, with Snorri and Bjarni and the rest of the company. They journeyed a long while, and until they arrived at a river, which came down from the land and fell into a lake, and so on to the sea. There were large islands off the mouth of the river, and they could not come into the river except at high flood-tide. Karlsefni and his people sailed to the mouth of the river, and called the land Hop. There they found fields of wild wheat wherever there were low grounds; and the vine in all places were there was rough rising ground. Every rivulet there was full of fish. They made holes where the land and water joined and where the tide went highest; and when it ebbed they found halibut in the holes. There was great plenty of wild animals of every form in the wood. They were there half a month, amusing themselves, and not becoming aware of anything. Their cattle they had with them. And early one morning, as they looked around, they beheld nine canoes made of hides, and snout-like staves were being brandished from the boats, and they made a noise like flails, and twisted round in the direction of the sun's motion.

Then Karlsefni said, "What will this betoken?" Snorri answered him, "It may be that it is a token of peace; let us take a white shield and go to meet them." And so they did. Then did they in the canoes row forwards, and showed surprise at them, and came to land. They were short men, ill-looking, with their hair in disorderly fashion on their heads; they were large-eyed, and had broad cheeks. And they stayed there awhile in astonishment. Afterwards they rowed away to the south, off the headland.

10. They had built their settlements up above the lake. And some of the dwellings were well within the land, but some were near the lake. Now they remained there that winter. They had no snow whatever, and all their cattle went out to graze without keepers. Now when spring began, they beheld one morning early, that a fleet of hide-canoes was rowing from the south off the headland; so many were they as if the sea were strewn with pieces of charcoal, and there was also the brandishing of staves as before from each boat. Then they held shields up, and a market was formed between them; and this people in their purchases preferred red cloth; in exchange they had furs to give, and skins quite grey. They wished also to buy swords and lances, but Karlsefni and Snorri forbad it. They offered for the cloth dark hides, and took in exchange a span long of cloth, and bound it round their heads; and so matters went on for a while. But when the stock of cloth began to grow small, then they split it asunder, so that it was not more than a finger's breadth. The Skrœlingar (Esquimaux) gave for it still quite as much, or more than before.

11. Now it came to pass that a bull, which belonged to Karlsefni's people, rushed out of the wood and bellowed loudly at the same time. The Skrœlingar, frightened thereat, rushed away to their canoes, and rowed south along the coast. There was then nothing seen of them for three weeks

together. When that time was gone by, there was seen approaching from the south a great crowd of Skrœlingar boats, coming down upon them like a stream, the staves this time being all brandished in the direction opposite to the sun's motion, and the Skrœlingar were all howling loudly. Then took they and bare red shields to meet them. They encountered one another and fought, and there was a great shower of missiles. The Skrœlingar had also war-slings, or catapults. Then Karlsefni and Snorri see that the Skrœlingar are bringing up poles, with a very large ball attached to each, to be compared in size to a sheep's stomach, dark in colour; and these flew over Karlsefni's company towards the land, and when they came down they struck the ground with a hideous noise. This produced great terror in Karlsefni and his company, so that their only impulse was to retreat up the country along the river, because it seemed as if crowds of Skrœlingar were driving at them from all sides. And they stopped not until they came to certain crags. There they offered them stern resistance. Freydis came out and saw how they were retreating. She called out, "Why run you away from such worthless creatures, stout men that ye are, when, as seems to me likely, you might slaughter them like so many cattle? Let me but have a weapon, I think I could fight better than any of you." They gave no heed to what she said. Freydis endeavoured to accompany them, still she soon lagged behind, because she was not well; she went after them into the wood, and the Skrœlingar directed their pursuit after her. She came upon a dead man, Thorbrand, Snorri's son, with a flat stone fixed in his head; his sword lay beside him, so she took it up and prepared to defend herself therewith. Then came the Skrœlingar upon her. She let down her sark and struck her breast with the naked sword. At this they were frightened, rushed off to their boats, and fled away.

Karlsefni and the rest came up to her and praised her zeal. Two of Karlsefni's men fell, and four of the Skrœlingar, notwithstanding they had overpowered them by superior numbers. After that, they proceeded to their booths, and began to reflect about the crowd of men which attacked them upon the land; it appeared to them now that the one troop will have been that which came in the boats, and the other troop will have been a delusion of sight. The Skrœlingar also found a dead man, and his axe lay beside him. One of them struck a stone with it, and broke the axe. It seemed to them good for nothing, as it did not withstand the stone, and they threw it down.

12. [Karlsefni and his company] were now of opinion that though the land might be choice and good, there would be always war and terror overhanging them, from those who dwelt there before them. They made ready, therefore, to move away, with intent to go to their own land. They sailed forth northwards, and found five Skrœlingar in jackets of skin, sleeping [near the sea], and they had with them a chest, and in it was marrow of animals mixed with blood; and they considered that these must have been outlawed. They slew them. Afterwards they came to a headland and a multitude of wild animals; and this headland appeared as if it might be a cake of cow-dung, because the animals passed the winter there. Now they came to Straumsfjordr, where also they had abundance of all kinds. It is said by some that Bjarni and Freydis remained there, and a hundred men with them, and went not further away. But Karlsefni and Snorri journeyed southwards, and forty men with them, and after staying no longer than scarcely two months at Hop, had come back the same summer. Karlsefni set out with a single ship to seek Thorhall, but the (rest of the) company remained behind. He and his people went northwards off Kjalarnes, and were then borne onwards towards the west,

and the land lay on their larboard-side, and was nothing but wilderness. And when they had proceeded for a long time, there was a river which came down from the land, flowing from the east towards the west. They directed their course within the river's mouth, and lay opposite the southern bank.

13. One morning Karlsefni's people beheld as it were a glittering speck above the open space in front of them, and they shouted at it. It stirred itself, and it was a being of the race of men that have only one foot, and he came down quickly to where they lay. Thorvald, son of Eirik the Red, sat at the tiller, and the One-footer shot him with an arrow in the lower abdomen. He drew out the arrow. Then said Thorvald, "Good land have we reached, and fat is it about the paunch." Then the One-footer leapt away again northwards. They chased after him, and saw him occasionally, but it seemed as if he would escape them. He disappeared at a certain creek. Then they turned back, and one man spake this ditty:—

"Our men chased (all true it is) a One-footer down to the shore; but the wonderful man strove hard in the race.* . . . . Hearken, Karlsefni."

Then they journeyed away back again northwards, and saw, as they thought, the land of the One-footers. They wished, however, no longer to risk their company. They conjectured the mountains to be all one range; those, that is, which were at Hop, and those which they now discovered; almost answering to one another; and it was the same distance to them on both sides from Straumsfjordr. They journeyed back, and were in Straumsfjordr the third winter. Then fell the men greatly into backsliding. They who were

* In this *lacuna* occur the words "af stopi," which Dr. Vigfusson translates, in his notes, "over the stubbles."

wifeless pressed their claims at the hands of those who were married. Snorri, Karlsefni's son, was born the first autumn, and he was three winters old when they began their journey home. Now, when they sailed from Vinland, they had a southern wind, and reached Markland, and found five Skrœlingar; one was a bearded man, two were women, two children. Karlsefni's people caught the children, but the others escaped and sunk down into the earth. And they took the children with them, and taught them their speech, and they were baptized. The children called their mother Vœtilldi, and their father Uvœgi. They said that kings ruled over the land of the Skrœlingar, one of whom was called Avalldamon, and the other Valldidida. They said also that there were no houses, and the people lived in caves or holes. They said, moreover, that there was a land on the other side over against their land, and the people there were dressed in white garments, uttered loud cries, bare long poles, and wore fringes. This was supposed to be Hvitramannaland (whiteman's land). Then came they to Greenland, and remained with Eirik the Red during the winter.

14. Bjarni, Grimolf's son, and his men were carried into the Irish Ocean, and came into a part where the sea was infested by ship-worms. They did not find it out before the ship was eaten through under them; then they debated what plan they should follow. They had a ship's boat which was smeared with tar made of seal-fat. It is said that the ship-worm will not bore into the wood which has been smeared with the seal-tar. The counsel and advice of most of the men was to ship into the boat as many men as it would hold. Now, when that was tried, the boat held not more than half the men. Then Bjarni advised that it should be decided by the casting of lots, and not by the rank of the men, which of them should go into the boat; and inasmuch

as every man there wished to go into the boat, though it could not hold all of them; therefore, they accepted the plan to cast lots who should leave the ship for the boat. And the lot so fell that Bjarni, and nearly half the men with him, were chosen for the boat. So then those left the ship and went into the boat who had been chosen by lot so to do. And when the men were come into the boat, a young man, an Icelander, who had been a fellow-traveller of Bjarni, said, "Dost thou intend, Bjarni, to separate thyself here from me." "It must needs be so now," Bjarni answered. He replied, "Because, in such case, thou didst not so promise me when I set out from Iceland with thee from the homestead of my father." Bjarni answered, "I do not, however, see here any other plan; but what plan dost thou suggest?" He replied, "I propose this plan, that we two make a change in our places, and thou come here and I will go there." Bjarni answered, "So shall it be; and this I see, that thou labourest willingly for life, and that it seems to thee a grievous thing to face death." Then they changed places. The man went into the boat, and Bjarni back into the ship; and it is said that Bjarni perished there in the Worm-sea, and they who were with him in the ship; but the boat and those who were in it went on their journey until they reached land, and told this story afterwards.

15. The next summer Karsefni set out for Iceland, and Snorri with him, and went home to his house in Reynines. His mother considered that he had made a shabby match, and she was not at home the first winter. But when she found that Gudrid was a lady without peer, she went home, and their intercourse was happy. The daughter of Snorri, Karlsefni's son, was Hallfrid, mother of Bishop Thorlak, the son of Runolf. (Hallfrid and Runolf) had a son, whose name was Thorbjorn; his daughter was Thorunn, mother of Bishop Bjarn. Thorgeir was the name of a son of Snorri,

Karlsefni's son; he was father of Yngvild, the mother of the first Bishop Brand. And here ends this story.

(This translation is made from the version of the Saga printed in Dr. Gudbrand Vigfusson's *Icelandic Prose Reader*. The passages in square brackets are taken from the Hauksbok version given in *Antiquitates Americanæ*. It may be mentioned here that Carl Christian Rafn and the other Danish scholars who edited this elaborate work have concluded that Kjalarnes is the modern Cape Cod, Straumsfjordr is Buzzard's Bay, Straumsey is Martha's Vineyard, and Hop is on the shores of Mount Haup Bay, into which the river Taunton flows.

English readers of Icelandic owe a large debt to Dr. Vigfusson for his labours in the cause of Icelandic literature. The great *Dictionary*, the *Sturlunga Saga*, and the *Prose Reader*, together make an undying claim on our gratitude; and yet they only show how very much more is still to be done. May we hope that Dr. Vigfusson will not cease from his labours until he has put forth a large instalment of the series which he has sketched in the able introduction to the *Sturlunga*, p. ccix.; and that the Delegates of the Clarendon Press will continue generously to appreciate his eager, scholarly, and laborious enthusiasm.)

LIFE OF MR. JUSTICE STORY,

ASSOCIATE JUDGE OF THE SUPREME COURT OF THE UNITED STATES.

By JAMES T. FOARD, Barrister-at-Law.

The subject chosen for this evening's consideration will, I fear, be found dull and uninteresting. Ordinarily, the lives or labours of lawyers create no sympathy with the personality of the lawyer. The individual who has been favoured with that choicest example of epistolary correspondence known as a lawyer's letter, is rarely inclined to pursue the acquaintance so auspiciously commenced, or desire a closer intimacy. Lawyers are popularly supposed to be so well able to look after themselves, and to obtain so adequate a reward in this world, without reference to the next or any other, that their history or biography, no matter what may have been their eminence, patriotism, or public service, presents but slight claim to public interest, and still less to enthusiasm or regard. At the risk of its being hinted that one lawyer has begun to praise another because no one else would, I wish to draw your attention to the public life and services of Mr. Justice Story, for some of the following among many other reasons.

The present Session of this Society commencing so nearly one hundred years after the birth of this very eminent American citizen, who was born in September, 1779, induced some feeling of surprise in my mind that so little notice was taken of an event in a world in which he, in his time, played, and in which he will continue long to play, so important a

part. No biography, no reference even by a casual newspaper paragraph, has been made, that I am aware, to the centenary of his birth. It may perhaps be said that he was not "of this parish," nor even of this country, but I cannot help thinking that his transcendant public services are more or less, from technical reasons, unknown, and that this cause chiefly, if not wholly, has induced apathy.

The life of Mr. Justice Story is identified almost completely with the history of his country. He became a public man at 28, a judge at 32, and Dane Professor at 50. He was born a little more than three years after the celebration of American independence and the creation of the Commonwealth, and he commenced his public labours almost as soon as its legal and judicial system had been framed and organised. He was thus associated with the rise and progress of American national existence, with the formation and establishment of its legal institutions, and with the growth of its commercial and political prosperity. With the establishment of its constitutional power, and the limitation of the jurisdiction of the various local and federal courts, he was, as founder and benefactor, even more intimately connected. Born in the very heart of a maritime and mercantile community, in one of the most actively intelligent and enlightened of the New England States, he exercised, in relation to the existing legal system of America, almost as important a part as was played by Sir Edward Coke in reference to that of England more than 150 years before. He was by nature an ardent reformer. By accomplishment and transcendant ability, he was able to realise his benevolent aspirations as practical benefits. He found the law overloaded with technicalities; the law maritime alike maimed in procedure and resource; the law relating to land in the highest degree complicated and obscure. The law of insurance had yet to be founded, some sixty decisions in the reports

and Magen's treatise comprehending all its extent. A new jurisdiction had been framed, and in the various newly-created district and circuit courts needed to be settled and defined, not merely in reference to inter-municipal law and its administration, but also with respect to all international relations, especially as to the rights of belligerents in capture, prize, and blockade. In this and kindred and collateral services his busy life was passed. He had appeared at a critical period in a nation's—in the world's—history. England had sacrificed 25,000 lives and fifty millions of money to enforce the dogma "that this kingdom has power, and of right ought to have power, to make laws and statutes to bind the colonies and people of America," and had failed to make that dogma comprehensible. The newly-begotten nation had also its axioms to propound, "that all men are born free and equal," and that "rebellion to tyrants is obedience to God." A national system of law based on this new departure, on a republican basis, with different responsibilities, aims, and resources from that of the parent country, required to be arranged and established. To organise, frame, and direct this process of reconstruction was briefly the mission of this pre-eminent judge.

England had supplied the foundations of the future legal and constitutional edifice to be erected, but at this time England was herself in the grip of a technical system of pleading and procedure, which Dean Swift had epigramatically satirised by suggesting that when a man wrongfully claimed a cow of another, the lawyers did not seek to ascertain who was the right owner, but set themselves to discuss whether the cow was red or black, was milked at home or abroad, or grazed in a round or a square field. Singularly, the two first judgments delivered by Mr. Justice Story from the judicial seat were on points of pleading not less unreasonable or

incongruous. What in the law was dark, he illumined; what was low, he raised and sustained. He found the law obscure and complex, he left it not absolutely simple—in law there is perhaps no simplicity, except that of litigants and offenders, not absolutely but relatively, simple—methodical, and practical. He assisted in introducing order into the chaos and complexity of chancery procedure. He advanced the progress of law greatly toward codification. He limited and defined the useful co-operation of juries in petty and personal litigation. He extended the bounds of Admiralty procedure and the benefits and utility of its legislation and cognisance, and by enlarging the jurisdiction of the circuit and district courts, gave to various local centres a finality in matters of procedure which they had not previously possessed. Finally, he earned for himself the distinction of being the most lucid expositor of the law of his age, in his own or any other country, and of having contributed and published a series of text-books which, alike for range of research, accuracy, dignity, and precision, have never been surpassed. If not the most profound lawyer of his time, he was certainly the most eminent, who had, in one sense, no rival in this hemisphere, no successor in his own. Of whom well inspired the oracle might have said, as of Socrates, "Best and wisest of men."

Joseph Story was probably descended from one of those Puritan families which had emigrated to escape the tyranny of Laud and Charles I. His father's name, Elisha, and the place of his birth, Marblehead, about four miles from Salem, in Massachusetts, as well as his mother's parentage and connexions, suggest that he sprang lineally from that small band of political exiles which was driven out by prelacy and political persecution about the year 1628–29, and that he was also presumably of Suffolk or Norfolk descent. From his early association and training, if not as a direct inherit-

ance, he acquired that self-reliance and independence of character, that sturdy republicanism, and that devout and religious bias of mind, which coloured his whole life. The hope and high enthusiasm expressed by the forlorn remains of that pious and persecuted band of pilgrims under the devout Endicott, was eminently characteristic of his life and aspirations. The answer returned by that heroic little company, which disease, war, and famine had left alive, to their sympathising brethren in England, "We are left a people poor and contemptible, yet such as trust in God and are contented with our own condition, being well assured that He will not fail us nor forsake us," was the spirit which breathed throughout the life and character of the future judge. The patient and unfaltering resolve, the stedfast faith and reliance on duty, were as strictly his distinction as the sources of their consolation.

His father had been an army surgeon, fighting, or perhaps it would be more accurate of a doctor to say—killing, on the side of Washington. A man whom his gifted son has described as of great tact and capacity, but with little pretension to learning. He appears to have been respected by his professional brethren, and when he left Boston to settle at Marblehead, he received from his friends the somewhat quaint testimonial, in reference to the qualifications of a medical man, that they could recommend him "as a gentleman of abilities and integrity in his profession, an assiduous asserter of the rights of his country, and a friend to mankind."

The future judge was one of eighteen children, and was the eldest of eleven by Elisha's second wife, Mehitable; and the first glimpse we have of his early life interesting to us, was of a studious finely-featured boy, keenly fond of books, with a singular love of study, whose emulation and desire to excel were constantly stimulated by his mother. She herself

said, in after years, that she used to say to him, "Now, Joe, I have sat up and tended you many a night when you were a child, and don't you dare not to be a great man."

Thus spurred on and incited to ambition, Joseph Story became, even as a boy, a diligent, emulous, and indeed an indefatigable worker; but the next more important glimpse we obtain of the future judge at this age, viz., fourteen, is by his own hand, and from his own autobiography.

The judge thus subsequently writes of himself to his son:—"I was about your age (14) when my father first began to give me his confidence, and to treat me as one entitled to it. He freely conversed with me on all his hopes and his situation in life, and taught me to feel the importance of firmness, sound morals, and an ambition of excellence. He told me that I should be obliged to depend on my own exertions for my success in life; that he should leave little or no property, and that I must study to fit myself for my profession in life. I never forgot his advice and kindness, it was present to me at all times, and gave a new turn to my thoughts. From that time I began to think that I ought to cease to be a mere boy, and to struggle for distinction as a man." *

This autobiographic incident opens out to us, better than pages of narrative, the necessity which existed for exertion, the honourable resolves, and the well-directed sense of duty of the boy. Up to this period he had enjoyed no exceptional advantages, if we except a most domesticated and loving father and mother, and a happy and affectionate home. He was no favourite of fortune, no lettered son of affluence, entering upon the labours of the law through the avenues of the highest social or university distinction and interest. He became a member of Harvard University (the proud bequest

* *Life and Letters of Joseph Story, Associate Judge of the Supreme Court of the United States*, by William W. Story. Chapman, 1851. Vol. i., p. 27.

of the Puritan founders of New England) at fifteen, under circumstances of peculiar discouragement. He knew little Latin, and less—which in this case meant not any—Greek, and he himself has suggested, in a passage which is not without a tinge of melancholy, that his first efforts at Greek in class, he having been wholly self-taught, were the subject of ridicule to his more fortunate classmates. His pronunciation was provincial. His accent suggested that he was self-taught, indicating, therefore, poverty, which, however respectable, is rarely respected. But Joseph Story had resources within him of self-reliance, honour, and nobility that defied augury. He persevered and prospered. At nineteen he was second only to Channing in distinction as a scholar. He was the superior of all his classmates in his capacity for systematic labour, "for taking pains," in his zeal for study, in his ability "to live like a hermit and work like a horse," and indeed in his prospects of success in that path to distinction which he had mapped out for himself.

I have little to say about his university career, except that it gave promise of his future life. The student was the father of the judge. He was an indefatigable worker, and endeared to all his associates by the simplicity of his manners, his active benevolence, even temper, and purity of life. He was genial, generous, and self-denying, with a capacity for friendship and affection of no common kind. The bias of his mind at this period was to poetry. He was eminently impressionable in reference to the charms of beauty both in nature and in art, and had thus, it must be hinted, an almost fatal facility for falling in love. He possessed that innate appreciation of ideal excellence and susceptibility to feminine perfection without which no ultimate eminence of the highest kind is perhaps ever attainable; and it is probably due to this cause, to his imaginative temperament, and his poetic aspirations, as well as to his practice in versification, that his

fluency and warmth of style, and the elegance and accuracy of expression in his judgments, no less than his catholicity and sympathy of character are chiefly to be attributed.

At nineteen he was launched upon the world, and commenced his legal career in the office of Mr. Samuel Sewall, an advocate of the Essex Bar, at Salem, in the same county, and was for the first time introduced to that eminent legist—with whom he has since been often compared—Blackstone, soon after making the (as he has himself recorded) dismal acquaintance of Coke upon Littleton.

The young student, at this time a very Crichton of poetic effusiveness, "fond of music and dancing," falling into love and inditing verses on the smallest provocation, who had written a poem called "Reason," which he had publicly declaimed at his College with much applause, who was a contributor to the newspapers, furtively concealing himself in the poet's corner, and who had dedicated an ode to the *Columbian Centinel*, was now to woo only that jealous mistress, the law. Before describing his own emotions in his own words, I cannot forbear presenting the generous tribute to his muse paid by the discriminating editor of the *Columbian Centinel*, who, ever on the watch for genius, thus, in the puff anticipatory and friendly, referred to his young friend. (He had inserted the poem in the previous issue.)

"The ode which, from a too cursory perusal, we had not duly estimated in our last, ranks among the happiest effusions of our classic groves. Its author, Mr. Story, is not only a *friend* but an *honour* to his country, and it is with pleasure we are informed that he is appointed to deliver a poem at the ensuing Commencement, from which the public may anticipate the fire of patriotism united to the energies of genius."

He, by his varied studies, his mode of life, and its pursuits, practically enforced the maxim he afterwards expressed

in his lectures, that nothing which concerns human nature or human improvement is indifferent or useless. He acquired many accomplishments, but none at the expense of the law. If he flirted with the Muses, the law was still his jealous mistress; he sought their favour without sacrificing his fidelity. His subsequent superiority as a judge, we might say, slightly altering the words of Johnson, was not gained at the expense of any pleasure in which youth might properly indulge, or by the omission of any accomplishment in which it would become a gentleman to excel.

With a temperament so ardent, with a zealous taste and zest for things beautiful and pleasant, with a thirst for all reading, whether metaphysics, history, philosophy, theology, novels, romances, or, above all, poetry, it may be assumed that the crooked crabbedness of Coke and the dry disquisitions of Fearne appeared discordant. Listen to what he himself has said. "To me the task (of acquiring law) seemed Herculean. I should have quitted it in despair, if I had known whither to turn my footsteps, and to earn a support. My father had often told me, in the sincerity of his affection, that he should leave little property; that the most I could expect would be my education; and that I must earn my livelihood by my own labours. I felt the truth of the admonition; and it was perpetually whispered into my secret soul whenever I felt the overpowering influence of any discouragement. My destiny was to earn my bread by the sweat of my brow; and I must meet it or perish."

"I shall never forget the time," he continues, "when, having read through Blackstone's Commentaries, Mr. Sewall, on his departure for Washington, directed me to read Coke on Littleton, as the appropriate succeeding study. It was a very large folio, with Hargrave and Butler's notes, which I was required to read also. Soon after his departure, I took it up, and after trying it day after day with very little success,

I sat myself down and wept bitterly. My tears dropped upon the book and stained its pages. It was but a momentary irresolution. . . . When I had completed the reading of this most formidable work, I felt that I breathed a purer air, and that I had acquired a new power. The critical period was passed" (in the pursuit of my profession), I no longer hesitated.

In February, 1800, General Washington died, and, with an entire absence of that species of social jealousy that prevails in some more considerable places, and which is a characteristic in the mother country, the town of Marblehead deputed Mr. Joseph Story, as one of its most rising young citizens, "who was not only a friend but an honour to his country," in the glowing language of the *Columbian Centinel*, to deliver an eulogy on the occasion, to sound the praises and heroic deeds of the great republican patriot and defender of his country. Mr. Story, on this occasion, framed a poetic effusion which the *Columbian Centinel*, ever on the watch to say a good-natured thing, styled "an elegant address." He also, about this time, being now of that age when the sentiments are at their most active flow, wrote a poem called "The Power of Solitude." At this time, if one might judge from his correspondence, his leisure was given up almost wholly to the poetic muse. He was at times greatly depressed, always sentimental, sometimes morbid, and in one of his fits of melancholy we find him writing in this Byronic strain:—"I have long ceased to admire the world. Its manners and its sentiments are equally objects of my disgust and detestation." He, however, passed through this phase of infantile disorder, which is perhaps as incident to youth as many more accurately defined epidemics, and sought his consolation successfully in labour.

About this time, viz., January, 1801, he left Marblehead, the place of his nativity, and went to live at Salem, about

four miles distant. He there entered the office of another legal advocate, Mr. Putnam, afterwards Mr. Justice Putnam. In July of the same year he was admitted as a member of the Essex Bar, and from this period his career is merged in his labours as a lawyer and in his public life. Salem was the tabernacle to which the intrepid Endicott, among the Pilgrim Fathers of 1628, had bent his steps. It was the seat and centre of New England Puritanism, and retained, even at this time, many of the associations connected with its first settlement. From 1801 until 1811, when Story was elected at the early age of thirty-two to a judgeship, he acted as a zealous citizen and politician. He was a constant contributor to the press. He, in 1804, published a volume of poems, which, fortunately for him, was but a qualified success. In the same eventful year he married his first wife, and published his first law book on practice. In 1805 he was chosen to represent the port and town of Salem in the Legislature of Massachusetts, having been, moreover, the selected orator to deliver the annual oration on the 4th of July, 1804, in favour of American independence. He took an active part in all the political movements of his place of residence, furnished the motto to *The Salem Register*, and busied himself in laying the foundations of that enormous store of legal knowledge which was subsequently to serve him so efficiently in his career of laudable ambition and distinction.

Before passing from these more personal details of his life, it would perhaps help to elucidate his public services in reference to the legal institutions of his country, and to general jurisprudence, if we glance for a moment at the position then occupied by America. The thirteen original American States which seceded from the parent government in 1786, and claimed their independence, had up to the period of their secession enjoyed the benefits of English law. Their fountains of law were the old reporters and the year

books. They acquired their views of personal liberty from Sir Edward Coke, from Magna Charta, and the Petition of Rights. In addition to their ordinary courts, they possessed Consular and Admiralty Courts, with a jurisdiction more extensive in admiralty and maritime causes than those of the mother country. They enjoyed the privilege of trial by jury. When their freedom was proclaimed, they were free to choose between the law of England and the civil law; between Blackstone and Justinian; between the case law of the mother courts and the system of the continental lawyers. They, moved either by preference, or prejudice, by accident or national bias, elected to maintain the existing law. They followed Sir Edward Coke, but, as Chancellor Kent has said, they claimed to pursue the English case law in the spirit of the French civilians. They sustained their system by all the stores of legal knowledge which the writings of Vinnius, Molloy, Casaregis, Domat, Puffendorff, and other eminent civilians had placed at their command, but the foundations were still English, and they still regarded with respect and admiration the useful and ungainly edifice which the English jurists had set up. They were emancipated from the tyranny of cases, and from the authority of judge-made law, and they elected to serve under it by choice. No longer compelled to obey, they became loyal Volunteers. English law was generally adopted. The decisions of the courts of the parent country, as modified by the philosophic views of the French professors, were introduced only in those branches of maritime jurisprudence in which the English law was presumably most maimed, limited, and defective.

At this period English commercial law was comparatively in its infancy. Before the advent of Lord Mansfield, who ascended the bench Nov. 11th, 1756, the Black-book of the Admiralty, and the mercantile and commercial treatises of Malyne, Molloy, Beawes, and Magens were the chief

sources of authority. On the subject of insurance, some sixty decided cases and the treatise of Magens, published in 1755, represented almost the entire bulk of learning in this vital branch of mercantile law.

Lord Mansfield, by his erudition, his knowledge of the civil law, and his commanding genius, became the founder of English commercial jurisprudence, and, in the words of Mr. Justice Story, "He was the jurist of the commercial world and the judge of every nation whose code is built on virtue and integrity." With these stores only at command, it became a necessity for the American people to found a national jurisprudence, the object being, as Lord Bacon has happily said, "the well-being of the people, the providing of everything necessary for defence against foreign enemies, and the establishment of a judicial, financial, and commercial system, under which wealth may be rapidly accumulated and securely enjoyed."

With a population vastly inferior to that of Great Britain, sparsely scattered over a wide area, with less accumulated wealth and an apparent absence of those resources of endowment, the aggregation of the wealth and stability of ages of civilisation and peace, the new Republic might naturally be considered at a disadvantage. The new courts of America, within the twenty years of Mr. Justice Story's appointment to the judicial bench, contributed a vaster store of legal lore, established more judicial principles in all the varied departments of law, than probably any other country, in any age. They started with the foundations of empire on their shoulders to solve problems which nine centuries of probation and conquest, had more or less imperfectly achieved for the states of Europe, and by the zealous aid of the judges arrived at a solution, which we can now, not too highly extol or admire.

When Mr. Justice Story, at thirty-two years of age,

took his seat as an Associate Judge of the Supreme Court, the six volumes of Robinson's Reports were all that existed of authority in Admiralty and Prize Law in America. The five first volumes of Cranch, Bee's Reports, Marriott's forms, and some cases in Dallas represented nearly all the available sources of precedent law. At this very period war was raging between England and America. Cases were daily occurring which had no precedent, no antecedent. The country was cut off by the war from the valuable stores of learning and decisions which Lord Stowell, then Sir W. Scott, was creating. The questions propounded and to be answered were infinite in complexity and novelty. Contracts of insurance and of prize, the law of salvage and collision, of blockade and embargo, the powers of masters of ships in reference to necessaries, the duties of mariners, all had to be defined. Into every department of these subjects Mr. Justice Story infused the spirit of equity, to adopt his own praise of Lord Mansfield, and applied the judicial decisions of the English courts so far as they were available. Admiralty and prize law had heretofore been administered in fishing villages and small seaport towns with a more extended if a less accurate jurisdiction than that which had been administered in London, in the centre of European civilisation. But the future course and destiny of these various consular courts required to be determined. The High Court of Admiralty of England did not, in executing justice, conform to the Common Law, or acknowledge the authority of any of its rules, governing itself wholly by maritime laws and usages, the ancient laws of the seas, and the forms of procedure of other maritime courts of Europe, as based upon the Roman law. This anomalous jurisdiction and arbitrary power had been distasteful to the common lawyers, who were opposed to any tribunal governed by the civil law, and which did not try by jury, and the judges, by the exercise of their prerogative in

the issue of writs of prohibition, had at various times limited and restrained the powers of this usurping tribunal. One of the first problems presented, therefore, at this early stage was, whether the future admiralty and maritime jurisdiction were to be based on the English or on the continental model. Notwithstanding his general reverence for the common law, Mr. Justice Story promptly made his election, and in one of the most learned and exhaustive judgments he ever delivered (De Lovio *v.* Boit, 2 Gall. 398), established, with the co-operation and sanction of his colleagues, Marshall C. J. and Washington J., the American courts on the basis of their primitive English jurisdiction before their authority had been maimed by prohibitions from the superior courts. But to meet this extended and in some senses anomalous jurisdiction, an entirely novel scheme of practice and procedure required to be framed. In a letter to Sir W. Scott, afterwards Lord Stowell, in 1819, Story J. referred in detail to the difficulties the jurists of his own country laboured under, from the absence of an ancient constitutional law to regulate the practice of their courts, and to the hindrances to be encountered in administering a new system of which the modes of procedure had not been familiarly preserved.

The powers he assigned to the newly-constituted district courts, in reference to admiralty and maritime causes, though at various times discussed and dissented from, have, after the lapse of sixty-five years, been generally confirmed. The jurisdiction in maritime causes, as he devised it, has been beneficially adopted and enforced. In this and kindred measures of reform, here but slightly indicated, the learned judge worked in no perfunctory manner, but with a zeal and energy boundless as his own enthusiasm. He personally superintended the establishment of a regular set of reports in each court in which he acted, and in great part assisted in composing and revising the body of the text of those which

enshrine his judgments, besides adding various learned notes. He in this manner contributed valuable additions to the volumes of Wheaton, Sumner, Gallison, and Greenleaf. Chiefly through his own exertions he was able, in an address delivered to the members of the Suffolk Bar (Sept. 4th, 1821), to say:—"The progress of jurisprudence since the termination of the War of Independence, and especially within the last twenty years, has been remarkable throughout all America. More than one hundred and fifty volumes of reports are already published, containing a mass of decisions which evince uncommon ambition to acquire the highest professional character. The best of our reports scarcely shrink from a comparison with those of England in the corresponding period; and even those of a more provincial cast exhibit researches of no mean extent, and presage future excellence. The danger indeed seems to be, not that we shall hereafter want able reports, but that we shall be overwhelmed by their number and variety."*

In addition to these services, by his essays and lectures on jurisprudence, his various and valuable editions of his works and his judgments, he was increasing the impetus already given to legal studies.

During this busy period of his increasingly laborious life it may be said that his legal triumphs were not gained at the expense of any pursuit or pleasure in which it became him as a judge to indulge, as a gentleman to cultivate, or as a philanthropist to retain. He was not a lawyer merely; he was a jurist in the largest sense. In 1819 he, in one of his charges, lifted his voice with no uncertain sound against slavery, and "that most detestable traffic known as the slave trade." The charge was so vehement, earnest, denunciatory,

* The Miscellaneous Writings of Joseph Story, Associate Justice of the Supreme Court of the United States and Dane Professor of Law at Harvard University. Boston, 1852, p. 212.

that it awoke the most angry feeling in the hearts of those who prospered by the traffic—by the Conservatives of that day. The step was so unusual and bold, that the timid and judicious considered it under the circumstances (as they always do) exaggerated and intemperate. Cynicism without conviction sneered at what it termed a maudlin enthusiasm. The newspapers talked of hurling the judge from the bench. He sat on undismayed. His judgment in "La Jeune Eugenie" (although it was not approved on appeal) testifies to-day, since its principles have been again and again affirmed, the strength of his convictions, the soundness of his reasoning, and the righteousness of his indignation. Time has established its truth, and has proved "that he did well to be angry." Of his character during this period of his presidence as a judge, we may indeed say in his own words, in his eulogy on Chief Justice Marshall, with an equal propriety, "There was nothing in his public or private career, his elevation as a judge, his consistency as a patriot, his sincerity as a politician, nothing to call for apology or for concealment. When can we be permitted again to behold so much moderation united with so much firmness; so much sagacity with so much modesty; so much learning with so much experience; so much solid wisdom with so much purity; so much of everything to love and admire, with nothing, absolutely nothing . . . to regret."

To be amiable as well as great; to be kind, gentle, simple, modest and social, and at the same time to combine the rarest endowments of mind with the warmest affections, is to possess a union of qualities which the sober experience of life rarely realises. Yet he manifested these and more than these diverse excellences.

In addition to his varied public duties of every kind, between 1804, when he issued his first legal work, and 1829 (June 11th), when he became Dane Professor, he had edited

and published many of his invaluable and vital juridical commentaries. Before his death, in Sept., 1845 (at 66 years of age), he had contributed to the legal literature of his country ten or eleven volumes on the following subjects:—*Bills of Exchange, Promissory Notes, The Law of Bailments, The Law of Agency, The Constitution of the United States, The Law of Partnership, Equity Pleadings, Merchant Shipping, The Conflict of Laws*, and *Equity Jurisprudence*, besides various essays, charges, and lectures of the most diverse kind, but chiefly referring to the progress and establishment of the legal constitution of his country.

It would be impossible within the brief limits of this paper to do full justice to the private life of the illustrious object of this most imperfect memoir, during the years between his appointment as judge and as Dane Professor and his death.

He had married, in Dec., 1804, Miss Mary Lynde Oliver, and this early marriage, at a time when his prospects in life appeared so high and prosperous, seemed to promise a life of domestic felicity. Unhappily, however, his wife's health began to decline almost immediately after their marriage, and his first hopes of wedded happiness were blighted by her early death, on the 22nd of June, 1805, and within six or seven months of the marriage. Two months after, his fondly-loved father followed, and the cup of worldly success was still further dashed. He was thus left as the eldest of his father's second family, their chief protector and guardian, with all the responsibilities which such a duty would necessarily entail on a sensitive and conscientious nature. In the early part of 1808 he became engaged to Miss Sarah Waldo Wetmore, the daughter of a judge of the Common Pleas, and on the 27th August was espoused to that lady, securing an affectionate helpmate in the mother of the judge's distinguished son, the poet and sculptor, and the biographer of

his father, Mr. W. W. Story. The second marriage was overshadowed during its earlier years by the loss of two or three of his children; but beyond these trials, more than ordinarily severe to an affectionate nature like his, his career as a judge from the year 1811 was comparatively unchequered and prosperous. It was a life of unremitting labour, but a life in which that labour produced its own exceeding great reward. It was his good fortune to be able to grace all that he undertook by success. Whatever he accomplished, secured honour and distinction, and was the best of its kind. His plans for the improvement of the condition of his fellow-men, not merely devised the benefit, but secured it. He was no ideal reformer, but a practical benefactor, who, pursuing no fleeting nor illusory aims, achieved the practical ends he sought.

All his labours it would be impossible to indicate. In 1804 he published his first law book, a selection of pleadings in civil actions, which was in practical use as a text-book forty years after. In 1809 he edited *Chitty on Bills of Exchange*. In 1810 he was busy on *Abbott on Shipping*, which he passed through the press in that year. In 1811 he edited *Lawes on Assumpsit*. From this period his judicial labours, and the production of his various commentaries on partnership, agency, bailments, promissory notes, the conflict of laws, equity jurisprudence, his world-famous judgment in "De Lovio *v.* Boit," his lectures on various subjects, and his schemes of law reform, seem to represent the labours, not of one, but of many men, not merely of a scholar, but of a university of scholars.

In 1808 he had moved for a select committee to consider the establishment of a separate Court of Chancery, with full equity powers, as a local court for the benefit of the State of Massachusetts. He wrote an elaborate report in favour of the creation of such an immediate jurisdiction, but that report was not accepted. He drew a bill providing for the establish-

ment of the tribunal, and defining its practice and system of procedure, and by ceaseless endeavour was ultimately successful. He projected a Supreme Judicial Court also for his native State, and an act to enlarge the jurisdiction of the Common Pleas. The object of these measures, he says in his report, was "to render the administration of justice simple, prompt, and cheap, to settle principles of decision which may stand the test of future scrutiny, to awaken the emulation of learned men, and to bring relief home to the doors of the oppressed and the injured." His various judgments, defining the jurisdiction of the circuit and district courts, and also of the state courts of chancery, induced that completeness, efficiency, and uniformity to which the legal system of America has been so greatly indebted.

The maxim *Nulla dies abeat, quin linea ducta supersit* was ever before him; that no day must pass without its line, and not one but many lines. "He dwelt ever in his great task-master's eye." His time was most conscientiously distributed, most laboriously occupied. His judgments, his lectures, his books, were models of painstaking care, and illustrative of that "capacity for taking pains" which probably exceeded that of any of his contemporaries. His efforts to reform and simplify the law were unceasing. His ideal government was one in which no grievance was to be without a remedy, no abuse was to become tolerable. From 1816, when he draughted the bill to enlarge the jurisdiction of the circuit courts, until he laboured in 1835 to 1845 to codify the law, his aims were all to the same end; and it has been mainly, if not wholly, due to his unparalleled industry and genius that the various codes of law which have been projected or passed in America were made practicable. Nor were his benevolent aspirations in reference to legal reform limited to his own country. Shortly before his death, we find him in corre-

spondence with eminent English legal functionaries on the subject of reforms contemplated or to be undertaken in the procedure of the English Court of Chancery. Very many of his suggestions, based on the system he had established in America, have been since adopted. Many have still to be applied. The fusion of jurisdictions, the establishment of district courts, with varied powers and a uniform procedure, administering commercial law and acting as chancery, maritime, and admiralty courts, coroners' courts and courts of common law, with uniform procedure and practice, have been among the projected reforms of successive Lord Chancellors. His scheme was designed to simplify the application of the highest legal principles and to bring the best available resources of the law within the powers of the humblest local tribunals. It would render this paper, I fear, far too dry and technical, if not unintelligible to a non-legal audience, if I did more than allude to some of these changes, which are due mainly, if not wholly, to his influence. The Admiralty Court Acts of 1840 and 1861, and the County Court Admiralty Jurisdiction Acts, were, in fact, the efforts of English statute law to achieve what he accomplished by three or four judicial decisions during his practice as a judge. The Judicature Acts, the simplification of the law in reference to legal titles to land, and the efforts made to give a maritime jurisdiction to county courts, abortive so far, are all reforms achieved under his protecting hand and by his aid in America.

His personal influence during his life in exalting the standard of legal excellence among his countrymen cannot be doubted. The existing State reports, and those of the various district and circuit courts, are in their form and treatment directly based on those admirable volumes of Gallison, Wheaton, and Greenleaf which he directly superintended, and the authority of which, so far, has not been

either discredited or impaired. His Essays, Lectures, and Addresses, as Dane Professor, constantly inculcated those lessons of honour and industry, probity and virtue, which were reflected in his life.

Without drawing invidious comparisons between our own legal system and that of America, it may safely be said, that its completeness and simplicity of procedure, and its prosperity and success, have been largely due to his labours. The mother country, by reason of the pre-eminence of its judges, still continues the primitive fountain of American jurisprudence. All the English reports are studied as zealously in America as in England. The systems and practice of the two countries, if not identical, are largely identified with each other, and very similar. On the other hand, very many of the decisions of Story, on commercial and maritime and insurance law, have been adopted in the English courts, and his judgments are constantly appealed to, and are accepted as of established reputation. Some of his views are in controversy, and have yet to be enacted in the form of judicial decision. But it is indisputable that his authority is cited in all points of dispute to which it is applicable, as that which is entitled to the greatest weight among foreign jurists. On certain vexed questions, notably on prepaid freight and its recovery, great judges have expressed a preference for Mr. Justice Story's decisions, even while administering existing law. His various—all but innumerable—judgments in every department of law—chancery, admiralty, commercial procedure—are, as the Honorable Daniel Webster has described them, "imperishable" and of "commanding authority all over the civilised world." In these he lives as an immortal. "*Vivit, enim, vivetque semper; atque etiam latius in memoria hominum et sermone versabitur, postquam ab oculis recessit.*" *

* *Life of Mr. Justice Story*, v. ii., p. 623.

In conclusion, we look on no public triumphs, on no ostentatious popularity, but on a life spent in silent labour, in a path of industry, which awakes no sympathy, kindles no enthusiasm, and which appeals only to a limited circle of critics, always cold, and occasionally censorious. We gaze, it is true, on no splendid conquests won only by the sufferings, the privations, or the destruction of the hero's fellow-men. His victories were bloodless and peaceful, earned by personal sacrifice, in the cause of mercy and truth. His aims were to man's protection and advancement; the cultivation of justice; the simplicity of law; the harmony of an exact and uniform government. To the promotion of these public benefits he consecrated, with unfaltering devotion, the private leisure of an unselfish life.

The simple recital, if it could be achieved, of what he accomplished, would be his best biography. His works are his noblest monument. In his life was no time wasted, no energy undeveloped, no talent misapplied; he pursued the purest ends by the purest means. On the bench he was uniformly courteous and urbane. He treated all who came before him with that kindness which springs from the truest nobility of nature. He never presumed upon his position. When he died he left confessedly a void, which has never since been filled. His friends, including the most distinguished men of his own country, the most accomplished jurists of every civilised society, have contributed to his memory the greatest uniformity of panegyric and unstinted praise probably ever conferred on a public man. His private life had been so genial, simple, and virtuous, his public career so unblemished, that it could not have been otherwise. He died, with all his faculties unimpaired, Sept., 1845, aged 66, and has left behind a reputation which shows no symptom of shadow or decline, from which envy or malice cannot detract, and which the wise and patriotic must ever continue to exalt and honour.

Finally, I would wish to summarise the biography of this eminent juris-consult in the happier language of an English judge, as that of one whose—

. . . "life has flow'd
From its mysterious urn a sacred stream,
In whose calm depth the beautiful and pure
Alone are mirrored; which, though shapes of ill
May hover round its surface, glides in light,
And takes no shadow from them."

PLAN OF A SELF-ACTING METHOD OF REGULATING THE STOCK OF GOLD FOR THE PAPER CURRENCY.

By JOHN DRYSDALE.

It may appear presumptuous on the part of one unconnected with banking, or any business pursuit in its ordinary sense, to speak on the subject above indicated; but it sometimes happens that a useful suggestion may strike an outsider whose view of the principle of the thing is not obscured by the innumerable technical details which occupy the daily attention of business men. At the same time, ignorance of technical details very frequently makes the reforms proposed by outsiders impracticable, and therefore I merely submit the following plan with the utmost deference to the judgment of practical men. In the first place, however, I must guard myself against the numerous misconceptions that are sure to arise the moment any one not a banker opens his mouth on the subject of the currency. I may therefore say at once that I am thoroughly orthodox on all the fundamental points. I have no theory of the possibility of an abstract pound sterling, but take it never to mean anything else than a certain weight of gold of a certain standard; nor do I believe that, by any law or regulation, gold can be made to have any other value than it possesses as a commodity; nor that the value of notes can be sustained in any other way than by convertibility at all times into gold; nor that any arrangement of the currency, however perfect, is sufficient of itself to prevent over-speculation and commercial crises. I believe

also that bi-metallism, or a double metallic standard, in the same country, with a fixed equivalent value, is against nature, and therefore a fallacy and an impossibility; and, in short, I subscribe to all the principles so admirably laid down by Mr. Picton a short time ago in this place. All I wish to suggest is that a natural self-acting process for maintaining the convertibility of the notes should be substituted for the judgment of men—even experts. It is obvious that if all the notes in the country merely represented an equivalent amount of gold laid up in the coffers of the banks, there could be no profit from the issue of notes except the saving of wear and tear of the gold, therefore, to get adequate profit, a certain proportion of notes must circulate that are not covered by gold in possession. That amounts in this country to fifteen millions for the Bank of England, and a certain fixed amount for all the other banks issuing notes which are convertible into gold on demand. It is the interest of the banks to keep as little gold as possible, and to lean on the Bank of England for a supply of gold when demanded for their notes. The amount of uncovered notes thus fixed above thirty years ago by the wisest men of the day may be absolutely right then, and for all time; but it may not, and it is possible that in determining the ratio between gold and notes, a rigid self-acting process, like that of a machine, or like the laws of nature, may be better than the direction of the highest human wisdom. Such a process may, I think, be found by an extension of Peel's Bank Bill of 1844, and certain additions engrafted on it. It would require the fundamental principle that the currency should expand and contract exactly as if it were purely metallic; and also that the issue department should be entirely separated from the banking department. Both these constitute already fundamental principles in the present system. But the second of them would require to be carried out more completely, and the

issue department separated bodily, in place and in name, from the Bank of England or any other bank, and from all connection with banking itself; for it is in reality a state issue of notes for currency only, not for lending as capital. There should, therefore, be constituted a State Currency Board or Office, and the notes should bear the title of State Currency Notes, or some such title. The Bank of England should thus be completely disestablished, according to the expression now in vogue, but with proper compensation; and the Government may still employ it, either alone or in common with other banks, for managing the national debt, or for banking purposes in general. This total separation from the Bank of England, although essential to my plan, is not peculiar to it, but is already admitted by practical men to be the logical outcome of Peel's system. For example, the writer of the article "Banking," in the new *Edinburgh Encyclopedia*, recommends it in the plainest and most uncompromising terms, alleging, among other reasons, that it would greatly facilitate the reduction of all the note currency of the kingdom to one kind, as desired by Peel. It would also show quite plainly to the public that the cry for ministerial help, by suspension of the Bank Act in times of crisis, was "nothing more than a claim for the nation to cover with its credit those who had not been prudent enough to maintain adequate resources for their own defence." (p. 327.) The gold in the issue department not belonging to the Bank of England, the suspension of Peel's Act on the three memorable occasions simply meant a permission to the directors to use the gold of the issue department for banking purposes, or to increase the amount of uncovered notes for the same purpose. No doubt, as the above writer says, the total separation of the State Currency Board from the bank would do much to hinder unreasonable clamour against the rigid application of the principle that the total

currency should expand and contract exactly as if it were all metallic. Yet I think cries for help from the Government in times of difficulty will never cease so long as an arbitrary amount of uncovered notes is fixed by law, guided by human judgment. For people will never cease to say that fifteen millions may not be the exact sum which was safe, right, and prudent at all times, and that a few millions more would be quite safe, and would be particularly useful at the present juncture, &c. This is one reason why the regulation of the amount of uncovered notes by a natural law is desirable. Again, when gold is leaving the country, from one cause or another, the natural remedy is the rise in the rate of interest, and consequent fall in the price of securities, which induces foreigners to leave it for investment and to send additional supplies, to take advantage of this increased rate of interest. The remedy ought to begin to be applied as soon as required, but when the application is left in the hands of the directors of the Bank of England, it is liable to be delayed too long, and until the efflux of gold begins to excite apprehension, and then the rate is advanced so suddenly that panic sets in. The Bank of England, competing for business with other banks, is always under the temptation to this delay, for the fear of loss disturbs its judgment; and it is tempted, like other banks, when money is plentiful, credit great, and speculation rife, to continue too long its banking facilities at a low rate of interest. There is also always a difficulty as to whether or not the currency is sufficient for the wants of trade or is redundant, and thus doubts may arise at what point the rise of interest should begin, if left to human judgment. But the only true test of the sufficiency of the currency as to quantity, again according to the writer above quoted, is the actual influx or efflux of bullion; if the imports exceed the exports of it the currency is deficient, and *vice versâ;* while, when they are in equilibrium, the currency is

sufficient. The inference is obvious, as it seems to me, that by a self-acting law the rise of the rate of interest should begin at the moment that the efflux begins to preponderate. Without further preliminary I may now proceed to the plan recommended for this purpose.

A State Currency Board should be constituted, totally independent of the Bank of England, or any bank, and also independent of all interference by the executive government of the day. Its functions should not be that of a bank in any sense, but that of issuing, and maintaining the convertibility of, notes issued solely against bullion paid into it. Let all money received in taxes, and all bullion voluntarily tendered, be paid into the State Currency Board Office, and for each sovereign or half-sovereign, or equivalent weight of bullion of requisite fineness, let a one pound or a ten-shilling note be issued in exchange; likewise, for every Bank of England note so tendered let gold be demanded, the note as now cancelled, and one for the same value issued in exchange. For these notes the State Currency Board shall be always prepared to deliver bullion on demand, and shall destroy at once every note so exchanged for gold. By this means the current gold coin of these denominations will ere long be displaced by notes, and the corresponding mass of gold, in addition to that represented by the Bank of England notes, will accumulate in the Board's cellars. But to render the substitution more complete, and to discourage the use of gold as the ordinary circulating medium, it is advisable not to coin any more gold for inland use, but to deliver it in exchange for notes, of a guaranteed fineness, by weight, and uncoined. No doubt a considerable number of gold coins would continue to circulate for some years, but it would not be desirable to hasten their absorption by any positive measure; for the constant liability to be tested for full weight would ere long cause universal preference to be given to the

notes. The gold coinage might still be retained for exceptional purposes, such as foreign war in semi-barbarous countries, although superseded by the state notes within the country.

The only legal tender in the country would therefore be state currency notes and gold, of certified fineness, whether in coin still circulating or in bullion, by weight. For small sums the silver and copper coinage remaining as now. After a time, as said, nearly the whole of the gold circulating as money, as well as the gold in the issue department of the Bank of England, not forming part of its capital, would be in the hands of the State Currency Board, and the quantity of it, as well as of the notes issued, accurately known. The point of the plan now is, that in order to obtain the full profit of the paper currency, and in order that the rise of the rate of interest should begin at the moment when the efflux of bullion begins, and increase *pari passu* with it, no attempt should be made to pay the notes from a stock of gold whose amount is fixed on banking principles, but that, at another department of the office, tenders should at once (*i.e.*, as soon as gold begins to be demanded for notes) be made for the purchase of gold by securities or deferred promissory notes at such a rate of interest as the market requires, only the comparatively small *minimum* stock of gold necessary for working the system being retained. All gold above this *minimum*, thus also a *maximum*, should be sold and invested, with the caution afterwards to be touched on, and the proceeds applied towards the reduction of the National Debt. The mode of fixing this *minimum* will also be considered afterwards; but, in the meantime, in regard to the interest-bearing notes, they may be managed by a special department of the office, which, for all sums taken from the *minimum* stock of gold, would offer an equivalent number of interest-bearing notes, of £100 and £50, at such a rate of interest as

will serve to attract gold and stop the efflux from the country. The best form of these interest-bearing notes would probably have to be determined by experience; but a convenient plan would be simply a promise to pay one year after date, £100 or £50 in gold by weight, *plus* the number of pounds sterling or their intermediate fractions bargained for, according to the supply of gold in the market at the time. It is obvious that as all ordinary notes are convertible into gold, holders of them should at once be allowed to exchange the sum for interest-bearing notes, if they desire to invest in them; notes so exchanged being destroyed in the same way as if gold had been paid for them. The effect of this would be a rise in the rate of interest, beginning immediately with the smallest preponderance of the efflux of bullion and corresponding contraction of the currency, and increasing *pari passu* with these regularly and smoothly, just as the resisting force of an elastic spring augments with the pressure applied to it. The consequent fall in the value of all securities, and ultimately of prices, which are the natural means of attracting bullion to the country, will now quickly stop the efflux, and reverse the direction of the flow of bullion, which will continue until the interest-bearing notes are no longer required, and bullion will be exchanged for ordinary notes. This (unless some other disturbing cause intervenes) will go on till the currency reaches its former dimensions. The gold thus received should be applied, first, to fill up the *minimum* stock, if that was not altogether done by the daily receipts brought in by the interest-bearing notes; secondly, it should be laid aside for the redemption of these interest-bearing notes when due. If the efflux continues till there is any surplus beyond that, the latter may be disposed of by investment in the same manner as the original stock derived from the gold now constituting the bulk of the circulating medium; while any deficit should be made up from that original stock, or its proceeds.

Is there, however, no fear that the somewhat sharp contraction of the circulating medium involved in the above plan would interfere to a dangerous extent with manufactures, trade, commerce, and the ordinary business of life? I think not, because the influence of the rate of interest of the state currency notes would be immediate and decisive on the general rate throughout the country; for when a certain percentage of interest is offered by the best security in the world, what bank can retain its deposits without giving a proportional rate of interest as long as that demand continues? The immediate rise of the rate of interest on deposits would thus at once tend to check the investment of money balances in interest-bearing notes; the tendency would, therefore, be to restrict the contraction of the currency to the destruction of those notes for which gold had been demanded. Things would thus very soon be brought to an equilibrium, and the efflux of gold generally stopped by a small rise in the general rates of interest and discount. In fact, as this country is already a centre for international payments, there is always a flow of gold towards it, and a sufficiency of this could always be easily diverted and retained here for profitable employment in filling up the wants of the currency; and, besides, the prospect of such profit would induce the constant importation of gold.

The paramount influence of the State Currency Board over the rate of interest on the plan here proposed, offers a strong contrast to the little power the Bank of England now has over that in ordinary times.

It is objected by John Stuart Mill that while the principle of making the currency expand and contract exactly as if it were all purely metallic, is good and useful at the early stages of commercial over-speculation, by placing an obstacle in the way of excessive credit, yet in the later stages that is more than counterbalanced by the extreme contraction

of the paper currency at the very time when an expansion of the proportion of notes uncovered by gold would prevent the ruinous fall of prices, and tide over matters until the gold has time to return in the ordinary course of trade. He seems to think that the banks, if not interfered with by the Bank Restriction Act, would be able to meet the difficulty; but his language is here rather vague and indefinite. And, looking at the matter from a scientific point of view, it would seem that the principle of acting as if the total currency were purely metallic ought to be followed out to its logical conclusion, and any departure from that is simply a step towards inconvertible paper currency, and any such tampering with the legal tender of the country ought to be quite inadmissible. It certainly would seem strange that, in a country with such vast realised property, the banks should not be able, without help from the State, and without tampering with the convertibility of the legal tender notes, to prevent the sacrifice of property in mere panic. They should, however, be left free to regulate their own affairs, and among them the stock of gold they deem necessary to keep up the value of their promissory notes as long as the public choose to accept such. It is enough that the State should make the only legal tender notes safe. It is also to be remembered that the contraction of the State currency in times of efflux of bullion would, to a certain extent, be compensated for by the issue of the interest-bearing notes, which would satisfy those inclined to hoard in times of difficulty or panic.

With respect to the fixing of the minimum or rather maximum stock of gold required to be kept when the interest-bearing notes are issued on the efflux of bullion, that ought, theoretically, to be as low as possible, in order to get the full advantage of the paper currency; but, practically, there should be enough—firstly, to give time for the system to work in bringing back gold; and secondly, for foreign gold to be

tested and purified; and thirdly, to obviate jobbing. Suppose we take first the largest quantity that has ever been taken from the Bank of England in a week in exchange for notes, and add to that the average for a certain number of days for mint purposes. How much these would be I have not the means of calculating, but let us say, for illustration, three or even five millions. To that add enough to defeat the efforts of jobbers, either single or in syndicates, or so-called "rings," who might try to exhaust the bullion, and thus take advantage of the exhorbitant rate demanded for gold. For this let us add two or even five millions more, and thus bring the total up to ten millions, an amount of gold that was thought sufficient by Tooke and Fullerton to meet the heaviest drain under the present system. With this stock the Currency Board could meet with calmness any demand for gold in exchange for their notes; while the issue of interest-bearing notes beginning at the same moment, would have time to work in replacing the stock. Whether the amount of stock on hand each day should be made public is a point that would bear discussion; it might perhaps be better that the public should only know the need of the Currency Board by the amount of interest offered on the deferred promissory notes given for gold.

As regards the surplus stock of gold, consisting of the bulk of the gold at present used as money, and which is variously estimated at from eighty to a hundred and twenty millions sterling, we should have to deduct, first, the above stock of ten millions, then the amount required for payment of the debt to the Bank of England. The remainder should then be sold and the proceeds invested in loans for public works, and the annual profits, amounting to probably from £2,000,000 to £3,000,000, after deducting working expenses, applied to the reduction of the National Debt. The investment of such a large sum in gold would, however, require caution, as if

thrown on the market in too large masses it would derange the natural operations of commerce, raising prices, and checking the exportation of British products. It would, therefore, require to be done in small amounts, or advantage taken of government requirements of specie to be sent abroad, of foreign loans, or payments [such as, *e.g.*, for the Suez Canal], or in other ways not necessary to follow out in detail. There would be some delay, therefore, before the full profit of the system would be reaped, but the system might be begun at once, even if the surplus gold were not all invested. The difficulties of disposing of the surplus stock of gold without seriously deranging commerce and all business may appear to some an insuperable obstacle to starting the plan into working at all. But to reduce this fear *ad absurdum*, we have only to imagine the discovery of a treasure or a gold mine in government property which yielded a hundred millions within a year or two, and then suppose that the most skilful financiers could not use it for the benefit of the nation by gradual investments in productive works here and payment of foreign debts, instead of suddenly throwing it on the market, doubling the currency, and doubling all prices for the time, and finally producing all the disastrous effects of a commercial crisis.

By means of the above plan the full profit of a paper currency would accrue to the State, and the principle of making the currency expand and contract, exactly as if it were purely metallic, would be carried out by a self-acting plan which would obviate all necessity for interference by the government in times of commercial crisis.

Among the objections likely to be made, may be noticed that against the small notes. The objections to small notes are summed up by J. S. Mill under two heads, viz., the danger of forgery, and the fear of loss by their non-payment falling on the poorer classes. But with respect to the latter,

the government security obviates it; and as to the former, the experience of Scotland and many foreign countries is sufficient to satisfy us of their practical safety. On this subject the writer in the *Encyclopedia Britannica* concludes:—"It is now generally admitted that the balance of argument is in favour of the issue of notes of this denomination [£1] by the Bank of England or some agency of the State, under conditions ensuring their convertibility."

There are many practical difficulties no doubt in the way of establishing such a system as is here set forth, and some may possibly be insuperable, although I do not at present see such. But the chief difficulty which may hinder even a full consideration of the plan is no doubt the unwillingness at first sight to trust to the ordinary operations of commerce for the supply of gold. For, in fact, the gist of the plan is to throw the keeping of the stock of gold on the ordinary operations of commerce, and it would need that there should always be a sufficiency of gold purchasable in the market to supply the demand. Such, I doubt not, would be the case, but as the demand for gold is under the influence of innumerable causes, there would be continual fluctuations in the rate of interest of the deferred promissory notes when they were required. Practically, however, no doubt the oscillations, though continual, would be small in extent between expansion of the currency at par and contraction with simultaneous purchase of gold at the expense of a rise in the general rate of interest, which might be described as premium; although incorrectly, if that conveyed the idea that gold would ever bear a higher value than the notes. I do not know that there is any experience to appeal to on the point whether the resources of commerce can be safely trusted to for the supply of gold which is now provided for by the gold coinage and by the Bank reserves, so we can only look to analogy for an answer; and here we find one which appears to be very much

to the point, viz., the supply of corn. Whether for weal or for woe, it is now the unquestioned fact that the corn grown in this country is hardly sufficient for more than half of the population now augmented by the effect of Free Trade. The failure of importation of grain for a few months would cause the death of millions of people, but we do not therefore make any special laws encouraging the importation of corn, nor do we keep huge State granaries with a supply of corn calculated to obviate all deficiencies of importation from temporary causes. On the contrary, all that is left to the natural operations of commerce, which have brought about a more abundant supply, and more stability of price, than could have been attained by the most skilful legislation or the most elaborate system of State barns. At the same time we have accepted the alternative, that in time of war the protection of the grain fleets and the commercial marine in general by a navy of unquestioned supremacy becomes a matter, not merely of more or less wealth, but of vital necessity. The importation of cotton and all other commodities is also left to the natural laws of trade. Why, then, should gold be an exception, seeing indeed that it is the most easily transported of all articles of value, and most generally in demand? The want of gold would at the worst be only an inconvenience and a loss, but that of corn is death. As far as analogy goes, therefore, the supply of gold may be left to the natural laws of trade. It may be granted that in the case of revolution, civil war, or overwhelming foreign war, the notes might become inconvertible and sink to a discount; but that has already happened under the old system, and things would be no worse under the new. On the contrary, they would be better, for the return to specie payments on the revival of credit would be much easier, seeing that there would be only a margin of gold to be provided.

In conclusion, I would submit that a plan is worthy of

earnest consideration which professes not only to carry out Peel's principle in a self-acting manner that obviates all appeal for governmental interference, but also to pay off the debt to the Bank of England; to provide the stock and expenses of its working; and to pay off about three millions sterling a-year of the National Debt; all without the addition of a single penny to the taxes, simply providing the means for these desirable results by the profitable employment of the gold which is lying idle in the pockets and tills of the people and the reserves of the Bank. Or, at least, if not lying idle, doing the work which can be done as well by notes of no intrinsic value, and in addition wearing out in the doing it, and thus subjecting us to the periodical loss and nuisance of light gold.

LIFE IN THE LOWEST ORGANISMS.

By the REV. H. H. HIGGINS, M.A.

About half a century ago, the French naturalist, Dujardin, discovered that the bodies of some of the lowest animals were almost entirely composed of a jelly-like substance, which he called *sarcode, i.e.*, resembling flesh.

Hugo von Mohl discovered a similar substance existing in all growing parts of plants, and called it *protoplasm*, from πρωτος, first; and πλασσω, I mould.

Max Schultze, it is said, demonstrated that the sarcode of animals and the protoplasm of plants were identical. On this I remark—No, not identical, but only indistinguishable by any experiment or mode of analysis known to science. Yet this was indeed a great discovery, establishing the fundamental unity subsisting between the animal and vegetable kingdoms.

Professor Huxley characterised protoplasm as "the physical basis of life." This expression has been extensively adopted; but many have been misled by it. No one has ever seen or known protoplasm except as *the* protoplasm of some special form of living animal or plant. Every living egg of a bird has a yolk, and yolk is the physical basis of all subsequent bird life; but no one has ever seen a general *fowline* yolk, but only the yolk belonging to the egg of some particular fowl.

Professor Allman says: "Wherever there is protoplasm there is life; wherever there is life there is protoplasm." Dead protoplasm, then, is not protoplasm at all, but only a substance having the appearance and some, or all, of the chemical constituents of protoplasm.

The molecular constitution of protoplasm is quite unknown: the application of chemical re-agents kills the protoplasm, and the experiments which follow are only a *post mortem* examination of its remains. Still, though it cannot be chemically analysed, protoplasm may be observed, and its behaviour, under a great variety of circumstances, may conveniently be studied.

Most observers agree that protoplasm is a tenacious fluid, structureless and transparent, with a consistency and a general appearance much resembling that of the white of an unboiled egg. Its fluidity seems to vary with the amount of water held in its composition. In certain seeds it is solid, and even brittle; but it is active only when in a fluid state. In the wheel-animalcules, protoplasm has the remarkable property of retaining its vitality for many years, when the ponds in which the animals reside have been dried up and the protoplasm has become indistinguishable from the dust formed by the desiccated mud. Yet, with its vitality it retains its specific character, and on being moistened it is developed only into the specific forms from which it was derived. Protoplasm is generally observed to contain a vast number of minute granules, rendering it more or less opaque; but these are probably foreign substances, taken up as food and retained until the nutritious portions have been digested and assimilated. All protoplasm is capable of becoming coagulated by heat, as the white of an egg becomes solid in boiling. But the most interesting property of protoplasm is its irritability; it is sensitive to the action of various stimulants, and under their influence it is able to overcome inertia, and to move: portions of it are able to flow away from the mass against the force of gravity, and these may be retracted so as again to form a part of the mass. Tremors have been seen to pass like ripples over the surface of protoplasm when no disturbing cause was visible.

In short, it is alive, and has the power of life-movements. But here I must pause. What is it that is alive—protoplasm? So it may be said. But might it not be better to say—it is the animal or plant to which the protoplasm belongs that is alive in its protoplasmic condition? The movement of protoplasm is no more wonderful than the movement of the animal, except that it occurs when it is not expected. Many of us have held a mummy-like chrysalis of a large moth in the hand, and when it has given a sudden wriggle we have been ready to drop it, not that it hurt us, but because we did not expect it to move. Looking at a little speck of jelly, we do not expect to see it move, and if it creeps this way or that, we are astonished; it seems almost as if mere matter could exhibit the activities of life; but if we recognise the jelly-speck as the lowest or embryonic state of an organism that swims or creeps about, we are less surprised and, it may be, better informed. It seems to be more in conformity with science to refer the motion to the living animal or plant, of which the jelly-speck is a condition, than to call it the property of a kind of matter of which we only know that it *never* occurs except as a constituent of an animal or a plant.

Every animal and plant, from a cheese-mite to an elephant, from a particle of red snow to a banyan-tree covering an acre, in the cycle of its individual existence, has once been in a protoplasmic condition. All living motion, all growth, and probably all thought or exercise of a will, is accomplished at the expense of protoplasm; but there are as many kinds of protoplasm as there are of living things, and indeed far more, for every part of an animal has its specially characterised protoplasm, and that which at the roots of our hair is employed in causing the hair to grow, differs from that which at the roots of our nails is occupied with forming nail substance and causing the nail to grow.

We are now prepared to accept as amongst the lowest forms of life those forms which present most closely and simply a protoplasmic character. Leaving, for the present, the vegetable kingdom, we pass on to examine the lowest forms of animal life. They are grouped together in a sub-kingdom which has been designated PROTOZOA. But amongst the Protozoa we shall find species varying to an extent that would seem to be incredible if the fact were not before our eyes. If we include the sponges, some individuals are of huge size; others are minute, though I am not aware that any animal is quite so small as certain organisms that have been referred to the vegetable kingdom. All the lowest of the Protozoa have been placed in a division which, for reasons which seem to me sufficient, I shall venture to term Root-footed Jelly-specks, *Rhizopoda*. Professor Haeckel has impounded a group at the very bottom of these, which he calls by a name meaning "simple," *Monera*. The members of this group are to all intents and purposes Root-footed Jelly-specks, but, as we shall see, they are judiciously placed by themselves.

Here, then, we can go no lower, and I shall have to describe to you an animal, the very simplest that is known to science. I shall call it the Orange Root-footed Jelly-speck. Professor Haeckel calls it *Protomyxa aurantiaca*. Now, in noticing the life-history of any animal or plant, one *must* cut into the cycle of life somewhere. We may begin with the egg, and then come to the bird, or begin with the bird and afterwards notice the egg.

In the orange jelly-speck we will start with what, perhaps, most resembles the egg of the bird, though the likeness is quite superficial. We have before us (see Plate, Fig. 1) the orange jelly-speck in the form of an orange globule smaller than a grain of mustard seed. It is made up chiefly of protoplasm; it is quite spherical and without protuberances;

Stages in the Life-history of

PROTOMYXA AURANTIACA,

After Haeckel.

MONERA.

Development of PROTOMYXA *aurantiaca.*

Figs. 1, 2. Encysted condition; and subsequent development.
" 3. Breaking up.
" 4. Pear-shaped bodies, incipient Plasmodia.
" 5. Tails retracted, true Plasmodia with pseudopodia.
" 6. An older Protomyxa; either a simple plasmodium, or several fused together.
A devoured *Isthmia* and a *Navicula* are visible.
" 7. Protomyxa aurantiaca, fasting: waiting for prey: numerous vacuoles.

it is alive, but it moves not—it is perfectly at rest. Watch it carefully, and you will see the contents of the globule assume a clustered form, like the lobes of a blackberry. (Fig. 2.) Keep on watching, and the globule will open, and the little blackberry lobes will swarm out, each lobe will develop a tail, and the whole swarm will wriggle about, this way and that way, like tadpoles at the edge of a pond. (Figs. 3, 4, 5.) Soon the tails will be absorbed, and the characteristic form of the root-footed jelly-speck will be assumed. Some of the specks will unite with others by simply flowing together to form a bigger speck. Parts of the body will be pushed out, like fingers or tentacles, and if they meet with particles of food, they will flow round it, and the particle, instead of remaining outside, will find itself inside the body of the jelly-speck. So the orange jelly-speck feasts and grows larger. And now we may notice a difference between two orange jelly specks. One of them is thickly charged with granules, which we now know are not protoplasm, but food or its remains; it may have swallowed two or three whole plants with their flinty skeletons, of which something may be said presently. At all events, it is gorged with food. (Fig. 6.) Observe its arms—they are not put out far, and the extremities are not stretched to their full extent, but form crescents. In a second example the body is contracted and encloses no food, but, as Haeckel himself says, it is in a starved or fasting condition. (Fig. 7.) Observe how much farther the arms are pushed out: the extremities are more divided, and are extended to the utmost; they now resemble the fibrils of roots, and since by these rootlets the jelly-speck is able to change its place, we see why it is called root-footed. But now they are not moving the animal: they are spread out like the lines of a spider's net to capture food, of which the jelly-speck, in its starved condition, is much in need. Finally, the jelly-speck may simply divide

itself to form other like jelly-specks, or it may assume its resting condition as a globule of protoplasm, with which we began its history.

Let it be remembered that this is the lowest known living animal, according to Professor Haeckel. If we observed the Monads, as Dr. Drysdale and Mr. Dallinger have beautifully shown, we should not get a life-history more simple, nor, in fact, very different. If we leave the animal kingdom, and betake ourselves to Bacteria and Vibrios amongst the lowest plants, we get higher conditions of life; that is to say, we find characters further removed from simple protoplasmic characters, such as we have agreed to regard as pertaining to the lowest and simplest forms of life. Of these we shall speak presently. What, then, may we observe in our orange jelly-speck?

1st. A strong assertion of individuality. It is needless to insist that it is not a portion of any other creature: it is a whole, and complete in itself. If the orange jelly-speck be not an individual, it is not easy to see why we should call an insect or a bird an individual.

2nd. It has periodicity. The old form inevitably dies and gives place to new forms. Its life cannot be prolonged beyond a certain time.

3rd. It has the power of reproducing its like, certainly in two ways, probably in more than two.

4th. It can digest and assimilate food unlike its own substance.

5th. It is capable of feeling hungry. This may require further notice.

When the root-foot, or any part of the margin, of a jelly-speck comes into contact with a particle of food, the protoplasm of the jelly-speck is said to be *stimulated* by the touch, and so it proceeds to enclose the particle by flowing round it. Though far from being an explanation, this may be left for

the present. But what is it that stimulates the jelly-speck, when in a starved condition, to spread its fibrous root-feet in every direction, though no food particles may be within reach? What is it that stimulates the spider to spread its net to catch flies? Instinct, certainly, whatever that may be. Yes, but in the spider instinct may be regarded as hereditarily derived through a pedigree of ages: it belongs to what Haeckel terms its phylogeny; it is the accumulated result of a long succession of advantageous increments. But in the jelly-speck we have no phylogeny, no pedigree; it is supposed to be the first-born of lifeless matter, unless, indeed, its ancestors were like itself only without the instincts. But if so, how did they live at all?

The figure is before us (Fig. 7) of the starved jelly-speck, with its root-feet spread wide, not from any external stimulant, but from some inner affection, comparable with hunger; it is something from within and not from without the jelly-speck.

It is a wondrous object for contemplation. The figure and the description are both from Professor Haeckel, who will not be supposed to be unduly prejudiced in favour of the line of thought I am endeavouring to follow. An objector may regard it as absurd to speak of a feeling of hunger as existing where there are no nerves and no organs of sense; probably the objector will attribute the phenomenon to automatic action. Such an assumption, however, is neither an explanation nor a disparagement. Shakespeare's plays have been regarded as simply the results of automatic action. On any hypothesis the fact remains the same. Here, where we cannot go back to preceding lines of evolution, where there is no hereditary chain that we know of, at the very base of the scale of life, hunger is exhibited, and we see the measures taken to satisfy it—hunger, which Professor Clifford declares to be one of the most complicated states of consciousness.

6th. Perhaps as a sixth character of the orange jelly-

speck, we may admit a tendency to assume a condition of rest. What that is, in the cycle of the creature's history, which inclines it to give up feeding and motion, and to repose for a while before breaking up into a swarm of progeny, it is hard to say. It may be induced by changes in the temperature of the medium in which it lives. But this does not seem altogether probable. Temperature alone will not account for the irresistible inclination to migrate, observable in birds, which we class with their hereditarily derived instincts. Perhaps this desire to rest may be admissible as the manifestation of a low form of instinct in the orange jelly-speck.

In passing to another aspect of the jelly-speck, we shall find it in possession of characters proper to the next higher division of animals, and we shall observe the former characters repeated, together with others in addition.

We come now to an animal which I may call the Changing Root-footed Jelly-speck, *Amœba*. For a long time it was considered to be the lowest form of animal life, but it has one or two very important characters which the orange jelly-speck has not. The changing jelly-speck has always within the protoplasm of which it is chiefly composed a more solid granular body, called the nucleus. Naturalists have agreed that the presence of a nulceus surrounded by protoplasm essentially constitutes a living cell—that wondrous biological *unit*, of which all the higher animals and plants are composed. The cell may or may not possess an outer skin; it must have a nucleus. The immense importance of the nucleus in the development of animals and plants consisting of many cells is a matter which does not belong to our present enquiry. The orange jelly-speck, having no nucleus, is not a cell; the changing jelly-speck is a true animal cell. One might wish it were possible to attain, even for a moment, a conception of all that a nucleated cell has been made to

accomplish in glorifying the face of nature with forest and fair flower and countless goodly tribes of animals upon the earth and in the ocean, in order that we might look with due interest on the first appearance of that which is an unit of them all. It is before us in the changing jelly-speck. We shall see fresh and wonderful things that the root-footed jelly-specks have been able to develop; but there will be nothing to surpass the first formation of a nucleus. In fact, no physical accession, morphologically, or physiologically, of equal importance with this, will occur again as we ascend the scale of life to the highest plant or animal. We may find multiplication of cells and combinations of cells to form tissues, and differentiation of cells for various physiological purposes; but the cell, the apparatus of life, comes into complete existence in a creature which resembles a mere dot of mucilage.

But the changing jelly-speck has another character scarcely less remarkable than the nucleus. Under the microscope may readily be detected within the body of the animal, differing from the rest of it, and quite unlike the nucleus, a portion like a *drop* * of clear liquid. With careful attention the drop may be observed alternately to contract and expand. Naturalists differ as to the function of this drop, the contractile vescicle, and some have thought they could observe little streams of liquid to issue from it on all sides at the time of its contraction. However that may be, there is evidently a rhythmical pulsation, as in the hearts of animals, in the breathing of all animals, including insects, and, with less distinctness, in the respiration of plants. This pulsation appears to me to be very wonderful when it is

* The terms "vacuole" and "vescicle," both of them in common use, are objectionable. "Vacuole" should imply that the space is comparatively empty; and "vescicle" that an integument is present; neither of them is appropriate here.

remembered that it takes place in a body without nerves or organs of sense of any kind, a mere speck of jelly. Like the nucleus, it is a foreshadowing of a character without which none of the higher animals and plants could exist; but why the nucleus and the pulsating drop should first appear together baffles all attempts at explanation.

The next aspect of the jelly-speck to which I would call your attention is observable in an animal which is essentially a changing jelly-speck, like the last, but with this peculiarity, that it is able to encase its soft body, doubtless for protection, with hard particles such as grains of sand. I will call it the Constructive Jelly-speck, *Arcellina* or *Difflugia*. What I have to say on it rests on the question whether it picks up these hard particles, or whether it secretes them. The balance of testimony is in favour of the picking up ; but if we credit Professor Henfrey, the matter is decided, for he says that in the granular envelopes of this particular jelly-speck occur the flinty valves of diatoms, which certainly were not secreted, though they may have been swallowed, by the animal.

No alternative seems to be left but to describe this habit of the creature before us as representing the first beginnings of that selective instinct by which living things choose and make use of suitable materials, birds build their nests, hundreds of insects shelter themselves and their brood, and untutored man himself sets up his hut or his wigwam. The constructive jelly-speck forcibly reminds us of the tubes, coated with small shells, inhabited by the larva of the Caddis-fly. Here, then, is a case of true instinct. We do not call the development of a nucleus, or a pulsating drop, an instinct, any more than we should say that the skeleton of a fish, or the shell of a mollusc, is a work of instinct. But when external materials are collected with apparently a considerable amount of dis-

crimination as to their suitability, surely this is instinct, though it be in a creature without nerves or organs of sense. We have by no means exhausted the powers capable of being stored up in the little root-footed jelly-specks, though the remaining divisions will not detain us long.

The lime-shelled jelly-specks are of very numerous kinds, indeed many hundreds of species have been recognised. They are best known by the name *Foraminifera*, given them because, in the majority of examples, the little shells which they secrete are perforated by many orifices, through which the animal puts forth its root-like jelly-feet. An entire paper might well be occupied with interesting details illustrating the lime-shelled jelly-specks. But these are readily accessible in almost any manual of invertebrate zoology; and our limits of time, space, and design require us at once to seize, if possible, the salient point in the biology of the lime-shelled jelly-specks. It is quite obvious; and if we had before us a schedule of the systematic arrangement of the lime-shelled jelly-specks, *Foraminifera*, the chief feature would immediately be manifest.

The animals form an order, but in the order there are sub-orders; in the sub-orders, families; in the families, genera; in the genera, species, hosts of them. Now, we may smile or frown at this wondrous piece of classification; still, it is the work of eminent men who have devoted a large share of time and study to the subject. It represents, there can be no doubt of it, a fact, and a fact of the very highest interest. In the lime-shelled jelly-specks we have a pattern of that vast systematic order which includes every living thing. Kingdoms divided into sub-kingdoms, sub-kingdoms into provinces, provinces into classes, classes into orders, orders into families, families into genera, genera into species, and species into distinguishable varieties. The very method by which these great divisions have been determined has been

followed in the classification of the lime-shelled jelly-specks. Certain characters, supposed to be of greater significance, have been selected to limit the families; others of less importance circumscribe the genera; a greater similarity, though still imperfect—for no two specimens are alike—has been thought to indicate an identity of thousands of specimens in the same species. And all this within the structureless group of the lime-shelled jelly-specks, which have no organs of any kind.

It is perfectly immaterial what value we may attach to the present methods of classification. What Nature has done on a large scale in segregating beasts and birds and insects and plants, she has done on a small scale, but on the same principles, in the microscopic world of the lime-shelled elly-specks.

We have only one other division to notice under the designation of Root-footed Jelly-specks—that of the Flint-shelled Jelly-specks, *Polycystina*. Details, however interesting, which can be found in text-books, must again be passed over in favour of the enquiry—What is the salient point? There is one word which expresses a very general impression made by the sight of them; and when seen under a microscope in a good light, I think out of a hundred observers beholding them for the first time, but without communication one with the other, ninety-nine would use the very same word and no other—beautiful! They are indeed pre-eminent in beauty; but what is remarkable is this—that the beauty of the glassy shell is far in excess of its apparent utility. In some of the cupola-like forms the body of the animal does not fill the shell, and the large apertures which confer such exquisite grace and lightness on the framework of the skeleton are unnecessarily capacious for the passage of the root-feet. In short, in the present state of our knowledge, the beauty of the polycystin shell can no more be accounted for by the

advantage it confers on the animal than the lovely markings and hues of rich colour on a butterfly's wing can be thus explained. Let me not be understood to sanction the inference that this beauty was developed only for man to admire, for this is not the kind of teleology that can bear examination. That we of the human race possess what we call a perception of beauty, is as sober a fact as any in the text-books: that the shell of this kind of jelly-speck exquisitely gratifies our sense of beauty is a fact which may be verified by experiment any day.

We have come to the end of the root-footed jelly-specks.

There are, however, three obscure forms which must be noticed, because, by some authors, they have been regarded as links between living and lifeless matter. 1. *Protamœba,* which is not an *Amœba,* but a *Moneron.* It has apparently been observed in one condition only, in which it seems to differ from a condition of the orange jelly-speck in colour alone. As known at present, *Protamœba* is quite worthless for biological conclusions. 2. *Eozoön.* The most recent researches have failed to confirm the supposed animality of *Eozoön.* 3. *Bathybius.* Given up by Professor Huxley. Sought for in vain by the Naturalists of the Challenger, whose negative testimony is almost equivalent to the assertion—"the sea saith it is not with me." The supposed absence of individuality in this obscure production is so violently opposed to that which is known of any other living thing, that we must regard it as having been observed only very imperfectly. Assuming the real existence of Bathybius, it seems closely to resemble the *plasmodium* of a myxomycetous plant, which originates and completes its cycle in a highly individualised form.

We may now recapitulate. If the results we have obtained appear to be unfamiliar, it is simply because our limited design has enabled us to observe the root-footed jelly-specks,

as it were, from below instead of from above. In the text-books, the order *Foraminifera*, for example, is presented as an enormous assemblage of minute forms, capable of being arranged in sub-orders, families, genera, and species, after a most imposing fashion; but these divisions relate, after all, only to the dried skeletons. Of course we are told that the animal is only a speck of structureless protoplasm; but this little fact often gets overlooked in such a formidable array of systematic names implying distinctions, which, biologically, may be of slender significance. On the other hand, we have attempted to approach the order from below, keeping fast hold of the idea intended to be suggested by the not very euphonious appellation—Root-footed Jelly-specks; and when we arrived at the army of Foraminifera, with its brigades, regiments, and battalions, to our apprehension it was simply a field for finding an additional character for *life*, as seen in the root-footed jelly-specks. It is no disparagement to good and necessary work done in classification, to say that Nature is not circumscribed by the methods employed in the text-books, but will repay attention honestly awarded to her under any and every aspect.

Certain of the foregoing characters, when taken in combination, furnish reasonable grounds for the inference that finally, as an accompaniment of life in the lowest organisms, may be regarded "idiosyncrasy," or a "constitutional peculiarity" in each specimen of a given species. Such a conclusion seems to follow from characters which may be termed appetences; an appetence being a tendency towards a certain course of behaviour, the tendency arising, not from the presence of an external stimulating object, but from a peculiar internal condition. Hunger, for example, is an appetence which may exist in every degree of intensity; and amongst a number of organisms of the same kind, one may be liable, under the same circumstances, to be much more

strongly affected by hunger than another. This is indeed an inference from *analogy*, and because it is so amongst the higher animals. Still, from the very nature of an appetence, unless two organisms of the same kind are precisely alike, under similar circumstances of privation of food, one might be much more keenly affected and stimulated by hunger than the other. The same may be said of the reproductive bias, the sexual appetence. Now, these two appetences are essential to the preservation and well-being of the species; but for the best results they must be in equilibrium, neither the one nor the other being greatly in excess. If, in an individual organism, the appetence for food should strongly preponderate to the neglect of the function of reproduction, the interest of its race would suffer, and the species would numerically be at a disadvantage. If, on the other hand, the sexual bias prevailed over the normal appetence for food, the progeny would suffer in health and vigour. A want of balance between two good and necessary appetences in an organism must issue in positive injury to the race.*

Constitutional differences between specimens of the same species in the lower classes of organisms, form an almost unexplored field in Biology. I have thought I could clearly detect diversities of temperament in Humble-bees (*Bombus terrestris*), and in House-flies (*Musca domestica*). Even amongst the Protozoa it may not be impossible to ascertain, by sufficiently numerous experiments, the existence of the same kind of idiosyncrasy that we recognize in quadrupeds, birds, and fishes.

* Something may be learned from a jelly-speck on that most vexed of all questions, the ' origin of evil." No malignant supernatural power need be invoked to account for injurious or even disastrous results; no qualities intrinsically evil need to be eliminated from living things. An imperfect adjustment between qualities good and indispensable in themselves, may be the source of all the mischief commonly attributed to propensities radically evil.

The following table contains a synopsis of the foregoing conclusions, so far as they concern the root-footed jelly-specks, which are manifestly the lowest living forms amongst the *Protozoa*.

ROOT-FOOTED JELLY-SPECKS. (RHIZOPODA.)

SIMPLE JELLY-SPECK. (MONERA.)

1. Individuality.
2. Periodicity.
3. Reproduction, indicating an appetence.
4. Assimilation.
5. Hunger, indicating an appetence.
6. Encystment.

CHANGING JELLY-SPECK. (AMŒBA.)

7. Development of a complete "cell," with "nucleus."
8. Development of a pulsating drop.

CONSTRUCTIVE JELLY-SPECK. (ARCELLINA.)

9. Selection of suitable materials, indicating instinct?

LIME-SHELLED JELLY-SPECK. (FORAMINIFERA.)

10. Development of Families and Genera.

FLINT-SHELLED JELLY-SPECK. (POLYCYSTINA.)

11. Development of a profuse variety of beautiful curvilinear forms.
12. Idiosyncrasy; constitutional peculiarity pertaining to each specimen.

We may now enquire whether any of these distinct and important characters can be found in lifeless matter.

The nearest semblance of individuality in lifeless matter may perhaps be found in a crystal; but a crystal undergoes no series of internal changes having reference to its totality. Periodicity is unknown in lifeless matter, any kind of which may, under proper conditions, be preserved unchanged for

ages. No living thing can be thus kept alive. The power of assimilation is equally restricted, for such processes as solution, chemical decomposition, and crystalization, afford no parallel with assimilation. Reproduction is too obviously peculiar to living things to require consideration here. The character derived from hunger as an appetence, can only be set aside on grounds leading to the total denial of an appetence as existing anywhere. The next character requiring notice—the production of beautiful forms—may be challenged as belonging also to things without life, since crystals, zeolites, and dendritic minerals often exhibit forms of extreme beauty. But the development of harmonious, curvilinear outlines, which abound amongst the lime-shelled and flint-shelled jelly-specks, is not found in the mineral kingdom. Even the graceful frost-foliage on the window-pane is not truly curvilinear. Under a good lens the frost-curves will be seen to be made by a succession of angular deviations, so that notwithstanding they are very lovely, they possess no true resemblance to foliage. In the shells of the jelly-specks may be found the initiative elements of almost all the kinds of beautiful form that we admire in the higher grades of animal life. Lastly, "idiosyncrasy" has been pretty fully considered.

Here, then, we have twelve of the most prominent characters in the world of life appearing in the lowest form of living things, whilst lifeless matter is destitute of any of them. We need not suppose that the whole number appeared simultaneously; yet the first four, or six, at least, must, it would seem, have attended the very birth of life. Such a sudden bound is not in conformity with what we are taught to regard as the mode in which evolution is conducted in Nature. In the present state of our knowledge, therefore, the beginning of life must, it would seem, be held to be an exception to *ascertained* continuity in Nature, as expressed by the theory of evolution.

Some years ago one of our most eminent men in science spoke of low fungoid conditions of growth in which the distinctions between living and lifeless matter were almost imperceptible. But botanical science does not recognise any such indeterminate forms of growth. In entire consistency with the theory of development, and without for a moment contending for the fixity of species, it may be asserted that every plant on the earth is after its kind—a general vegetable is quite unknown. Perhaps the nearest approach to the "low fungoid growth" referred to may be found in a production termed Rhizomorpha, which is a mass of barren filaments attaining a size sufficient to fill unused railway tunnels or the adits of mines. This mass is supposed to be produced by various species of fungi; but no one doubts that each fibre originally sprang from spores of a special kind of fungus. When the whole life-history of the fungus is taken into account, there is no longer any resemblance between its life and any condition of lifeless matter.

The extreme age and permanence of some lichens may be adduced as indicating a kind of intermediate condition between life and no life. Mr. Ruskin says of lichens:—"Sharing the stillness of the unimpassioned rock, they share also its endurance; and while the winds of departing spring scatter the white hawthorn blossom like drifted snow, and summer dims on the parched meadow, the drooping of its cowslip-gold—far above, among the mountains, the silver lichen-spots rest, star-like, on the stone; and the gathering orange-stain upon the edge of yonder western peak reflects the sunsets of a thousand years."

There is scarcely more life in portions of the lichen-crust than there is in a fossil fern. All living things are made up of protoplasm, and formed or dead matter such as hair and shell; and if the dead matter be permanent, it must not be misunderstood as possessing a low vitality

because it has originally been formed under the influence of forces peculiar to life. Take the whole life-history of the lichen, there is nothing in the history of inorganic matter that in the least resembles it.

There is a very prevalent misconception that an organism so small as to be but just visible under the most powerful microscopes, *Bacterium termo*, for example, is likely to have been spontaneously generated. It is forgotten how far such an organism is from atomic size and simplicity. *Bacterium termo* has countless cilia, and each cilium is a wand obeying the mechanical laws of elasticity. If I string a bow, heat is evolved on the side next the string, and absorbed on the outer side. Must it not be so with every swing of a cilium, which is thus far enough away from the confines of the homogeneous? Mere minuteness in the size of an organism has *nothing whatever to do* with the possibility of its spontaneous generation. Some of us may remember the experiments of Mr. Cross, in which the notorious *Acarus*, something like a cheese-mite, was supposed to issue, under the microscope, from a pinch of electrified salt. This was, scientifically, as great a blunder as it would be to expect to see an elephant generated by a thunder-storm on the Pitch Lake of Trinidad.

To conclude. The time has come for us to cease regarding "vitality" as a friend to be backed up, and "spontaneous generation" as an enemy to be put down. I have spoken the more freely because I can now see that "spontaneous generation," if established beyond a doubt, need not in the least interfere with our recognition of One Supreme Will, all powerful and all benevolent, as the source of all order. At the same time I feel strongly that the assumption that we possess complete theories, such as evolution is by some supposed to be, does infinite mischief, inasmuch as gigantic speculations dwarf and disparage the hard-earned stores of true knowledge.

PLASMODIUM OF A MYXOMYCETOUS FUNGUS.

By the REV. H. H. HIGGINS, M.A.

I will endeavour to describe an experiment which circumstances enabled me to make in the Autumn of 1879. Amongst the plants allied to mushrooms, toad-stools, truffles, moulds, and such like, collectively known as Fungi, occur a group of small plants, *Myxomycetes*, so extraordinary in their transformations that they have been classed with animals. Their spores, instead of developing soft cottony threads, *hyphæ*, often composing a delicate kind of network or mat, *mycelium*, turn out their contents in the form of minute specks of protoplasm. By-and-by, through the absorption of food and moisture, these specks grow and unite, constituting a net or bed, or cushion of protoplasm, *Plasmodium*. On a layer of damp sand, under a glass shade on my study table, I placed chips of decaying wood on which were growing about half-a-dozen kinds of these fungi. After a while, one of the most common of them, *Æthalium septicum*, distinguished by its soft consistence and sulphur colour, almost disappeared, and the chip on which it was growing was found to be covered with a thickish cushion of semi-transparent olive-brown jelly. This result, as it was exactly the kind of thing I was hoping and expecting to see, left me in no doubt that I had at length before me a myxomycetous fungus in its protoplasmic stage. It was evidently the developed and united contents of many spores, but I could not be certain that the cushion was generated by the spores of the fungus which had disappeared, though this was at least probable. After many hours of careful watching, for several days, I could detect no signs of life, no tremors passed across its surface, no fingers were protruded from its edges; it was, in short, entirely inactive. It then occurred to me that its dark olive-brown colour and its highly granular consistence, might indicate that it was

1. Viscid patch of protoplasm, olive-brown, with granules.

2. Neck.

3. Pure water—Pellucid protoplasm, margin shewing the development of pseudopodic projections.

supplied to repletion with food, and was consequently dull and lethargic, like a snake after a hearty meal. Small portions of it in a drop of water under the microscope, expanded so as to fill the drop with a brown granular jelly, but no movements could be observed. This drop was suffered almost to dry up, leaving only a patch of viscid film on the glass slide. Its fluidity being thus diminished, a second drop of pure water was placed on the glass slide, the edge of the drop being about one-eighth of an inch from the viscid patch. With the point of a penknife the water was led to the edge of the patch, so that the patch and the drop were connected by a narrow neck of water. In about four hours the protoplasm of the viscid patch had crept down the neck, leaving all the granules and brown colouring matter behind, and was developing itself in the drop. The protoplasm in the drop was in a perfectly pure and pellucid state, and its edges could only be detected by a slight difference between the refractive powers of the water and the protoplasm.

The margin of the protoplasm, delicate and all but invisible as it was, now showed unmistakable movements and forms of life; fingers were put forth which moved with a very slow but distinct motion; a "T" shaped prominence appeared in more than one place, and a very curious crater-like summit was seen, to which converged many extremely attenuated lines visible only by their unequal refraction. Some of these lines could be traced as proceeding from the narrow neck connecting the drop with the patch. The plasmodium was now evidently seeking food, and though the drop was pure, and contained no nutritious particles, I had no doubt whatever that had the protoplasm come in contact with any such particles, it would, after the fashion of an amœba, have enclosed and assimilated them.

The fungi which pass through the condition in which

they are known as *plasmodia*, are by no means simple in form. Most of them are small, though not microscopic, in size, and their organs of fructification are often extremely beautiful in structure, form, and colour. Ninety-eight species have been described as natives of Great Britain.

My experiment confirms the now generally accepted conclusion that protoplasm, when pure, is perfectly structureless, colourless, and, *so far as can be seen*, homogeneous. The physical agent in producing the whole of the characters observable in animals and plants is, so far as can be detected, one and the same in all. Protoplasm is probably as invisible as air, the presence of which can be detected through the eye only by the impurities floating in it, or by strata of air of different densities causing unequal refraction of light, as may often be seen when the sun is shining intensely on a hayfield.

PRELIMINARY REPORT ON SPECIMENS DREDGED UP FROM THE GULF OF MANAAR, AND PRESENTED TO THE LIVERPOOL FREE MUSEUM, BY CAPT. W. H. CAWNE WARREN.

By H. J. CARTER, F.R.S., &c.

The Gulf of Manaar is an inlet of the Indian Ocean, between Ceylon and the southern extremity of India; 150 miles in width at its entrance; and the specimens, which were dredged up by Capt. W. H. Cawne Warren in 65 fathoms and less, off the town of Negambo, near Colombo, on the coast of Ceylon, and Tuticorin, on the coast of India, respectively, towards the end of 1878, were presented to the Liverpool Free Museum about a year afterwards, when they were sent to me for examination.

As they all possess a similiar facies, it will only be necessary to allude to them hereafter as "from the Gulf of Manaar," without specifying the particular locality more than has already been done.

Altogether, they would hardly fill a quart measure, and the largest was not more than three inches in its longest diameter, so that the amount of material is insignificant, but the representatives of species comparatively enormous, as will be seen hereafter; indeed, if this material is to be taken as typical of what is to be found in the Gulf of Manaar generally, I should think that this little inlet must contain an epitome of nearly all the marine organisms that exist in the Indian Ocean.

The "specimens" consist of calcareous nodules of different sizes, which may be said to be composed of "sea-bottom," brought together, in the first place, by some

agglutinating organism, and thus individualised and rendered transportable, increasing in bulk by subsequent additions as they are currented about, until they may at last attain almost unlimited dimensions. They are, therefore, composed of all sorts of organisms, whose embryos, swimming in all directions in search of a resting place, find them, although still free and detached, of sufficient weight and solidity to offer a convenient position for development; hence the diversity of species in and about them.

They vary in form and weight, in proportion to the loose sand or solid material in them, some being round, hollow and clathrous; others much creviced; and some entirely solid; while they may be more or less rugged on the surface from the nature of the organisms of which they are composed, whether through development *in situ* or subsequent detrital agglutination. Perhaps no family of organisms has entered more into the solidity of their composition than the Calcareous Algæ (Melobesiæ), which, in successively laminated or nulliporoid growths, have so increased their size and weight that, in some instances, the nodules are compact and strong generally, while in others they have grown out into short round processes, after the manner of a Nullipore. I am not sufficiently acquainted with the Calcareous Algæ to say what the species about these nodules are, but the common encrusting one hardly differs from our *Melobesia polymorpha*, and this also, by successive lamination, seems to grow out into the nulliporoid form mentioned. There is also another species with larger cells, which are oblong and quadrangular, but it is not so common; while the loose, deciduous, flat, reniform articulations of *Flabellaria opuntia* are agglomerated with everything, showing that this Calcareous Alga or Coralline, which is very common in the tropics generally, is not less so in the Gulf of Manaar.

As it is upon these agglutinating compounds, as well as in

their crevices and the excavated cavities formed by lithodomous sponges in them, that the organisms to be hereafter mentioned have been developed, I shall henceforth allude to the former under the term of "Melobesian Nodules."

Next to the part which the *Melobesiæ* have taken in their formation may be mentioned the sessile Foraminifera, and these have, in their turn, been overgrown in many instances by Polyzoa. This, too, is a class of which I know so little that I am not able to point out the different species present, so have placed those which have necessarily become separated, while breaking up the nodule for other specimens, in a box by themselves, for someone who, desirious of describing the Exotic species, may hereafter be permitted to examine them for this purpose. They are as beautiful as they are abundant, and, besides those which are separate, there are many others still on the larger fragments of the nodules which will be returned with the general collection.

For my own part, the Foraminifera and Spongida are as much as I can pretend to undertake, which, together with a new genus of Hydractiniidæ, and a new species of *Tubipora*, will be described and illustrated in the June (1880) number of the *Annals and Magazine of Natural History*. The Spongida, which are now under similar preparation, will, I hope, appear in the following number; the former having been sent to the Editors of the periodical mentioned, on the 30th March, and the latter will be forwarded to the same destination by the end of April.

But although the forms of the Foraminifera are fully developed, and therefore admit of complete description and illustration, those of the Spongida, in many instances, are not so. Then it should be remembered that the form of a fully-developed Sponge is frequently by no means constant, while every fragment of it is almost sure to contain its whole spiculation, and this is just what is found in several instances

on the Melobesian Nodules; while the name of a Sponge, for the most part, being derived from the *form* of its spicules, enables us to supply this together with a description of the latter, which is all that is required until the fully-developed Sponge is found. That such full developments do exist in the deeper water of the same locality, I do not doubt, where, from its stillness, they could attain a size that the current in the shallower parts would render almost impossible.

Here I would observe that the "mountings" in Canada balsam that I have made of some of the "dust" that fell off the root-branch of *Euplectella cucumer* (now in the British Museum), which was hooked up by a man while deep-sea fishing in the neighbourhood of the Seychelles, afford a *complete index* to the Manaar specimens, with many other forms besides, which may yet exist in living sponges in this locality, at the same time indicating, like many of the specimens on the Melobesian Nodules, that, as yet, we have hardly entered upon the dawn of all the sponge life that exists on the surface of the globe.

But I have not observed any gold-grains among the sand obtained from some of the nodules (by acid solution), although the blue sapphire which is found in Ceylon, is as evidently present as in the sea-bottom from the Seychelles. (*Ann.*, 1878, vol. i., p. 102.) It is interesting, however, to note such coincidences, both mineralogically and biologically, in localities not so very wide apart.

Another fact I would also mention here, viz., that throughout my examinations, which have been chiefly conducted under the microscope, often with high powers, I have never observed a *coccolith*, *coccosphere*, or *rhabdolith;* while the fragments of *Melobesiæ*, accidentally mounted with the sponge specimens, strikingly resemble in their calcareous cells thus aggregated, what the *coccolith* presents when separate.

The descriptions and illustrations respectively of the new form of Hydractiniidæ and the new species of Tubipora, have, for convenience, been placed with the Foraminifera now under publication, but in the general list, which will be hereto appended, they will be found in their proper positions respectively.

With reference to the measurement of the spicules of the Spongida, I would also add that their form is of much more consequence than their dimensions, as the latter may vary, 1st, in different specimens of the same species, as I shall have to notice by-and-by, when the description of a fully-developed form of a specimen from Australia (*Suberites fistulatus*, n. sp.) will be given to illustrate a fragment of the same species on a Melobesian Nodule from the Gulf of Manaar; 2nd, they differ in the same specimen, where they are often present of different sizes, on account of their development, like that of everything else, being from small to great; and 3rd, that the fully-developed spicules vary in measurement in proportion to their stoutness, the latter being the shortest, and *vice versa*. My measurements must only be considered, therefore, as approximative of the latter.

Following is the list to which I have above referred of those organisms in and about the Melobesian Nodules of the Gulf of Manaar that I have thought most deserving of enumeration. In it the species which are new, and that I have consequently had to name, will be marked "*n. sp. var.*" or "*nov. gen. et sp.*," as the case may be. I do not pretend to include any of the microscopic organisms, ex. gr. Foraminifera, Diatomaceæ, &c., but all the larger and more striking forms of the Foraminifera, and most, if not all, the Spongida. These will be illustrated by specimens and one or more slides respectively, which, having already been prepared, I propose finally to label, arrange, and hand over to the Liverpool Free Museum, as the "Manaar Collection."

The advantage of having specimens in addition to the slides is that the latter can thus be replaced if accidentally broken.

LIST OF ORGANISMS FOUND IN AND ABOUT THE MELOBESIAN NODULES, DREDGED UP IN THE GULF OF MANAAR, BY CAPT. W. H. CAWNE WARREN.

ALGÆ (calcareous).

Melobesia (?) polymorpha, laminiform.
—— polymorpha, nulliporiform.
Melobesia, quadrangular-celled, laminiform, ? sp.
Flabellaria opuntia.

FORAMINIFERA.

Sessile.

Polytrema miniaceum.
—— cylindricum, n. sp.
—— mesentericum, n. sp. *Loc.* unknown, not Gulf of Manaar.
Carpenteria utricularis.
Carpenteria monticularis.
Gypsina melobesioides.
—— vesicularis.
—— ——, var. spheroidalis.

Subsessile.

Rotalia spiculotesta.
Orbitolites marginalis.

Free.

Calcarina calcar, var. hispida, n. var.
Alveolina sinuosa, n. sp.
Amphistegina.
Holocladina pustulifera, nov. gen. et sp.
Cysteodictyina compressa, nov. gen. et. sp.
Ceratestina globularis, nov. gen. et sp.
—— tessellata, n. sp.

SPONGIDA.

Ord. ii. CERATINA.

Aplysina purpurea, n sp.
Aplysina fusca, n. sp.

Ord. iii. PSAMMONEMATA.

Hircinia arundinacea, n. sp.
Hircinia fusca, n. sp.

Ord. iv. RHAPHIDONEMATA.

Chalina ? sp. (young).
Desmacidon Jeffreysii, *Bk.*

Ord. v. ECHINONEMATA.

Pluriformia.

Dictyocylindrus manaarensis, n sp.
Dictyocylindrus sessilis, n. sp.

Microcionina.

Microciona atrosanguinea, *Bk.*
—— armata, *Bk.*
—— affinis, n. sp.
—— bulboretorta, n. sp.
—— quadriradiata, n. sp.
—— fascispiculifera, n. sp.
Microciona curvispiculifera, n. sp.
Hymerhaphia vermiculata, var. erecta, *Carter.*
—— unispiculum, n. sp.
—— clavata, n. sp.
—— eruca, n. sp.

Baculifera.

Caulospongia, *Kent*, ? sp.

Ord. vi. HOLORHAPHIDOTA.

Thalyosa.

Reniera ? sp. Brown and white.

Crassa.

Reniera ? sp. Yellow and yellowish grey.
Reniera ? sp. White.
—— ? sp. Dark brown.

Fibulifera.

Reniera fibulifera, *Schmidt.*

Halichondrina.

Halichondria aceratospiculum, n. sp.
Halichondria albescens, *Johnston.*

Esperina.

Esperia tunicata, *Schmidt.*
Esperia serratohamata, n. sp.

Hymedesmina.

Hymedesmia stellivarians, n. sp.
—— Moorei, n. sp.
—— capitatostellifera, n. sp.
Hymedesmia spinatostellifera, n. sp.
—— trigonostellata, n. sp.

Suberitida.

Suberites vestigium, n. sp.
—— fistulatus, n. sp.
Suberites angulatus, *Carter.*

Placospongida.

Placospongia melobesioides, *Gray.*

Ecoelonida.

Thoosa socialis, n. sp.
Dotona pulchella, n. sp.
Alectona Higgini, n. sp.
Samus anonymus, *Gray.*
—— simplex, n. sp.
Samus (Pachastrella) parasiticus, *Carter.*
—— complicatus, n. sp. Seychelles.

Geodina.

Geodia perarmata, *Bk.*
—— areolata, n. sp.
—— ramodigitata, n. sp.
Geodia globostellifera, n. sp.
Stelletta euastrum, *Schmidt.*

Stellettina.

Stelletta tethyopsis, n. sp.
Tisiphonia nana, n. sp.
Tisiphonia (prov.) annulata, n. sp.
—— (prov.) penetrans, n. sp.

Lithistina.

Corallistes aculeata, n. sp.
—— verrucosa, n. sp.
—— elegantissima, n. sp.
Discodermia papillata, n. sp.
Discodermia aspera, n. sp.
—— spinispirulifera, n. sp.
—— lævidiscus, n. sp.

Ord. viii. CALCAREA.

Gen. Leucortis indica, *Häckel*, ? sp.

SPICULES OF UNKNOWN SPONGES.

HYDROIDA.

Hydradendrium spinosum, nov. gen. et sp.

ACTINOZOA.

Alcyonaria.

Rhizoxenia, *Ehr.*, ? sp.
Spongodes, *Lesson*, ? sp.
Tubipora reptans, n. sp.

POLYZOA.

A great variety of species undetermined, ? sps.

TUNICATA.

SYNASCIDIÆ, Giard.

Tribe i. *Didemnidæ* (with spicules).

Leptoclinum, *Milne-Edwards*. White, incrusting, ? sp.

GASTEROPODA.

Siliquaria anguina.

SPICULES OF KINDS.

Drawn into the crevices and excavations of the Melobesian Nodules (? by Foraminifera or Spongida), there are several forms of deciduous sponge-spicules which in some instances may be traced to growths on the Nodules themselves, while there are others of whose origin, so far, there is no indication; but among these are some which are so peculiar and beautiful,

that they alone might suggest a name for the sponges from which they respectively came, and these I have mounted in Canada Balsam for the guidance of anyone who hereafter may feel inclined to seek for specimens of the sponges to which they respectively belong.

Among the ninety organisms mentioned in the List there will be found twenty-four which have already been named, fourteen of doubtful nomenclature or not named, and the rest, viz., fifty-two, among which there are four genera new to science. Only those which have not been named by myself have, for the most part, the authors' names respectively entered after them.

Two of the species, viz., *Polytrema mesentericum*, of whose locality I am ignorant, and *Samus complicatus* from the Seychelles, having been described and illustrated in the detailed "Report" which will be published in the "Annals," are thus inserted in the "List;" and among the slides (about 144), which finally, as above stated, will be handed over to the Liverpool Free Museum, will be found some which have been added from my own collection, to make that from the Gulf of Manaar more useful.

Mr. Higgin made the following remarks:—

Captain Cawne Warren, to whom the town is indebted for the "Manaar Collection," has been an Associate of the Literary and Philosophical Society since 1868; during which time he has constantly been doing excellent work for the Liverpool Free Museum, but his last gathering from the Gulf of Manaar and Bass's Straits is much the most valuable yet brought home by him. The Bass's Straits dredgings have not yet been examined, but from the paper just read, we find that in eighty specimens of Spongida, Foraminifera, &c., from the Gulf of Manaar, no less than fifty-two are species new to science. These were found in comparatively shallow water, and Mr. Carter seems to have no doubt that from greater

depths in this favorable locality, better specimens of these new species, as well as more novelties, will be obtained. It is therefore greatly to be desired that Captain Cawne Warren and other of our Associates, who may have occasion to visit this interesting Gulf, will bear this in mind, and that before long we shall have dredgings from its deepest and stillest parts.

I had hoped to have had Mr. Carter's Report and the objects themselves, in time to prepare a short paper on this valuable collection; but owing to its richness in new species, the length of time required for examining, figuring, and describing so many novelties has been much greater than was anticipated, and the work has not yet been completed. Many of the specimens are of the greatest interest, and they will probably form subject-matter for a communication to the Society next session.

ON THE CLASSIFICATION OF THE CHEMICAL ELEMENTS, AND MENDELEEF'S PERIODIC LAW.

By J. CAMPBELL BROWN, D.Sc.

Classification is necessary in order to assist the mind in grasping and the memory in retaining the facts of nature; but it has in modern times a far higher use, namely, to show the analogies between individual facts and to assist in the discovery of new ones.

All early classifications of natural objects were artificial, and useless for every purpose except to facilitate recording and reference. Every one knows that the Linnæan classification of plants placed species of entirely different characters together in the same group, merely for the artificial reason that they had the same number of stamens and pistils; and it separated the nearest relations if one of them had a stamen or two more or less than the others; while more recent *natural systems* place in the same group those plants which are found by a comparison of all their important characters and properties to be most nearly allied.

So amongst mineral substances, we find in the *Systema Naturæ* of Linnæus:

Ambra,
Succinum,
Bitumen,
Pyrites, and
Arsenicum

classified together under the head of "Sulphura"!

The first great division of the chemical elements which has any pretension to be natural is into metals and non-

metals. This division was first made on account of the difference in appearance and general physical characters between the two classes, but when it became difficult to determine the position of an element, such as arsenic or tellurium, whose physical characters were not decided, the possession of chemical properties resembling those of decidedly metallic or decidedly non-metallic elements was made the criterion.

The electro-chemical character has also been used as a means of classification; metals being electro-positive and non-metals electro-negative when their compounds are submitted to electrolysis.

I have placed on the wall a diagram showing the classification, which was used ten years ago, according to what is called the atomicity or quantivalence of the metals and non-metals respectively. The elements which have been discovered more recently have been added in their proper places in this diagram.

It is well known to the members of this Society that in order to account for the four fundamental laws of chemical combination, namely, the laws of combination in :—1st. Definite proportion ; 2nd, Multiple proportion ; 3rd, Reciprocal proportion ; and, 4th, The law of the combining proportion of compounds,—Dalton revised the old Greek idea of atoms and enunciated the theory that elements necessarily followed these rules, because they are composed of indivisible atoms of uniform and constant weight, and therefore they cannot do otherwise ; the combining proportions being in the ratio of the weights of the atoms or groups of atoms.

* * * * *

For the last sixteen years the metallic and non-metallic elements have been classified according to the number of atoms of hydrogen, or its equivalent, which each atom can

replace, or with which it can combine. This hydrogenicity is called the "atomicity," or better, the "quantivalence" of the element.

* * * * *

After making allowance for all the corrections required, this system of classification is not quite a natural one, although it is to some extent based on analogies.

Boron^{III} and Silicon^{IV} resemble each other as much as Silicon^{IV} and Carbon^{IV} do.

Silver^{I} more resembles Copper^{II} than the alkaline members of the monad group.

Fluorine^{I}, Boron^{III}, Aluminum^{IV}, Gold^{III}, Uranium^{IV} and Thallium^{III} have no real analogues among their neighbours in this system.

As in the vegetable and animal kingdoms we find that it is impossible to draw a hard and fast line between different classes and orders, while each order runs by gradations into each of its neighbours, so we find a gradation in the properties of the elements which the theory of atoms and atomicity does not account for, nor our system of classification express.

For very many years groups of elements have been recognised whose members possessing similar chemical properties have atomic weights which are related to each other in a very simple manner. For instance, the group of Halogens :—

Chlorine, atomic weight	= 35	
Bromine		= 80
Iodine nearly	= 125	
	2 / 160	
	80 = Bromine.	

These elements are strictly analogous in their modes of combination, their salts are isomorphous, and with the

increase in their atomic weight there is a uniform modification of their properties; Chlorine is a green gas, Bromine a very volatile red liquid, while Iodine is a slate-coloured solid, volatilized only by heat.

Chlorine is most active chemically, and can expel the others; Bromine is next, and Iodine least active. Chloride of Silver is easily soluble in Ammonia, Bromide of Silver soluble with difficulty, and Iodide of Silver not at all.

Similar relationships between the properties and the atomic weights are seen in the most common alkaline metals:

Lithium - -	= 7	
Sodium - -		= 23
Potassium - -	= 39	
	2 / 46	
	23 = Sodium;	

and in the metals of the alkaline earths:

Calcium -	= 40	
Strontium -		= 88 nearly.
Barium -	= 236 nearly.	
	2 / 176	
	88 = Strontium nearly.	

Many fragmentary relationships of this kind have been pointed out by Dumas, Newlands, Meyer and others. They are well known, and have been considered little more than curious coincidences.

Among the so-called organic compounds, that is the compounds of Carbon, groups are known whose members differ from each other by CH_2 or a multiple; their weights therefore differ by a multiple of 14.

$$\begin{aligned} C &= 12 \\ H_2 &= \underline{\ 2} \\ & \quad 14 \end{aligned}$$

Such groups are called homologous series, and the members have similar properties, which are modified in a regular manner with the composition ; for instance, in some of the best known groups the boiling point is increased 19° C for each increment of CH_2.

Are the regular differences in the groups of elements to be explained by a regular difference in the constitution of the elementary atoms? This question cannot be answered at present, nor can it ever be answered in the affirmative without modifying the hitherto received notion of the ultimate nature of the atom.* But we cannot look at Mendeleef's tabulation of the elements without recognising that there is some relation between the atomic weight and the properties of an element, whether that relation is one of cause and effect or not; for it is hardly possible to believe that the relations observed between the atomic weights of similar elements are merely accidental.

Mendeleef does not speculate regarding the causes, but generalizes the facts in the form of a law as follows :—

"*The properties of simple bodies, the constitution of their compounds, as well as the properties of these compounds, are periodic functions of the atomic weights.*"

If we make a list of the elements arranged in the order of their atomic weights (see page 291), the first thing that we find is that their properties vary little by little as the atomic weights increase.

Omitting Hydrogen, which is the only known member of its series, we find that the next seven elements in order

* The old idea of the simplicity and indivisibility of the atom is gradually giving way to a belief that its nature may be complex, without, however, affecting the idea of the atom as the unit of a simple substance, which cannot be subdivided without destroying the characters of the element as we know it.

combine with a regularly increasing proportion of Oxygen, and the last four combine with a regularly decreasing proportion of Hydrogen.

The next thing we find is that the variation of the properties receives periodically a similar modification.

The ninth element, Sodium (Na = 23), does not unite with still more Oxygen, but is similar to Lithium, and unites with Oxygen in the proportion Na_2O. It is therefore placed below Lithium; but as it resembles Sodium less closely than Potassium does, it is not placed immediately under Lithium, but a little to one side; in the same group, but in a different subdivision of the group. The next element, Magnesium (Mg = 12), bears a corresponding resemblance to Glucinum, and combines with Oxygen in the proportion Mg O. The next element, Aluminum (Al = 27·7), like Boron, combines in the proportion Al_2O_3.

Silicon (Si = 28), like Carbon, combines with Oxygen in the proportion Si O_2, and with Hydrogen in the proportion Si H_4.

Phosphorus (P = 31) forms P_2O_5 and PH_3; Sulphur (S = 32) forms SO_3 and SH_2; while Chlorine (Cl = 35·5) forms Cl_2O_7 and ClH. These elements unite respectively with other elements and other compound groups of elements, called radicals, in the same proportions as with Oxygen.

The next element, Potassium, resembles Lithium more closely than Sodium, and is placed immediately below it. And so on; we find that the elements arrange themselves into eight groups, that the properties of each group are repeated at regular intervals, and that in a consecutive series of the elements, allied elements which belong to the same natural family recur at regular periods.

There is a relation not only between the forms of the compounds, but also between the chemical and physical properties of the elements and their atomic weights. The lower

groups are metallic and basic;* the higher are non-metallic and form acids.

The third horizontal series contains the elements whose characters are most marked; all the members combine with Oxygen; the first oxide, Na_2O, being a strong alkaline base; the second, MgO, less powerfully basic; the next, Al_2O_3, a very weak base, which also combines like an acid with stronger bases. The next, $Si\,O_2$, is a weak acid radical; the next, P_2O_5, forms stronger acids; and the seventh, Cl_2O_7, forms a most powerful oxydising acid. Only the last four combine with Hydrogen. HCl is a strong acid, as those who pass Runcorn and St. Helens know; and it is stable. H_2S, another Runcorn gas, called Hydrosulphuric acid, is a very weak acid and not very stable, inasmuch as it burns in the air when heated.

In PH_3 the acid character is lost and the gas is very unstable, forming the well-known "Will-o'-the-Wisp."

$Si\,H_4$ is not an acid, and is still more unstable. It, as you see, takes fire spontaneously.

There is a remarkable gradation in the physical properties; for instance, in the specific gravities.

Na	Mg	Al	Si	P	S	Cl
·97	1·75	2·67	2·49	2·1	1·96	1·33

The volatility decreases to Silicon, then it increases to Chlorine, which is a gas at ordinary pressure and temperature of the air.

The gravities of the oxides are:

2·8	3·7	4	2·6	2·7?	1·9

* A basic element is one which does not unite with hydrogen, but unites with oxygen, forming bases, and with chlorine, forming salts. The acidifying elements combine with hydrogen; they also combine with oxygen, forming acid radicals, and when they unite with chlorine they form only chloranhydrides, not salts. Some intermediate elements partake of the two characters in different degrees of combination.

Gradations are seen in other series, *e.g.*,

Ag	Cd	In	Sn	Sb	Te	I
10·5	8·6	7·4	7·2	6·7	6·2	4·9

The elements placed in the same perpendicular group are closely allied to each other, form similar compounds, belong to the same natural family, and have the same quantivalence according to the old system of classification.

The elements of the 3rd, 5th, 7th and 11th; that is, the odd series, resemble each other in each group more closely than they resemble the corresponding members of the even series, while these latter show a closer resemblance between themselves; *e.g.*, the even series do not give organo-metallic compounds, that is, compounds with alcohol radicals, in the higher groups, as the members of the odd series do; and the basic character is more strongly marked in the odd series. These distinctions do not always hold in Series II., but then we must remember that the differences between the atomic weights in Series I., II., and III. are much less than between the other consecutive series.

The differences between consecutive members of the same group is nearly the same figure, or a multiple of the same figure, but the differences between the first three series are lower than between the higher series.

The differences are as follows:—

Group I.	Group II.	Group III.	Group IV.	Group V.	Group VI.	Group VII.	Group VIII.
16	15	16·3	16	17	16	16·5	
16	16	16·7	20	20	20	19·5	
24	25	24	2 × 21	24	26	25	2 × 24
22	22	21	28	19?	18?	2×23·5	
23	25	24	22	26	29?		
25	25	25	3 × 22	3 × 21	3 × 20		4 × 23
3 × 22	3 × 21	3 × 22	24	28?	2 × 28		

LIST OF THE ELEMENTS CLASSIFIED IN ACCORDANCE WITH MENDELEEF'S LAW.

Series.	Group I.	Group II.	Group III.	Group IV.	Group V.	Group VI.	Group VII.	Group VIII.
				RH_4	RH_3	RH_2	RH	
	R_2O	R O or R_2O_2	R_2O_3	RO_2 or R_2O_4	R_2O_5	RO_3 or R_2O_6	R_2O_7	RO_4
1	H 1	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	
2	Li 7	G 9·4	B 11	C 12	N 14	O 16	F 19	
3	Na 23	Mg 24	Al 27·3	Si 28	P 31	S 32	Cl 35·5	
4	K 39	Ca 40	Sc 45 44	Ti 48	V 51	Cr 52	Mn 55	Fe 56, Co 59, Ni 59, Cu 63.
5	(Cu 63)	Zn 65	Ga 69·7 68	72	As 75	79 Se 78	Br 80	
6	Rb 85	Sr 87	Yt 89	Zr 90	Nb 94	Mo 96	100	Ru 104, Rh 104, Pd 106, Ag 108.
7	(Ag 108)	Cd 112	In 113	Sn 118	Sb 120	128 Te 125	I 127	
8	Cs 133	Ba 137	La 138	Ce 140	? *Di* 144	? *Di*	? *Tr 148*	
9	,,	,,	? *Er 169*	,,	,,	,,	,,	
10	176	177	? *Er 178*	180	Ta 182	W 184	190	*193?* Os 195, Ir 197, Pt 198, Au 199.
11	(Au 199)	Hg 200	Tl 204	Pb 207	Bi 210	214	,,	
12	220	,,	,,	Th 231	235	U 240	,,	

Or, if the even and odd series be compared separately, we find the following differences :—

Group I.	Group II.	Group III.	Group IV.	Group V.	Group VI.	Group VII.	Group VIII.
22							
32	31	33	36	37	36	36	
40	41	42	44	44	46	44·5	
46	47	44	42	43	44	45	48
45	47	44	46	45	47	47	
48	50	49	50				
2 × 45	2 × 44	2×45·5	2×44·5				
				2 × 44	2 × 44		2 × 45
				2 × 45			
			2×45·5		56 ?		

The eighth group consists of metals which form links between the seventh members of the even series and the first of the odd series, and the whole table should be represented as a cylinder on which the elements are arranged in a spiral manner. The way in which the two ends of the table, as represented here on a flat surface, should be joined together, is shown by the occurrence of the symbols for copper, silver, and gold twice; once at the end of Group VIII., because they are highly metallic bright hard elements, and form higher oxides than R_2O, and again in Group I., because their lower oxides, such as Ag_2O, are isomorphous with the alkalies. The metals of Group VIII., except those which join into Group I., are all of a grey colour, have low atomic volume, that is, their atomic centres are very near to each other, and hence they are all fusible only with difficulty, the highest members being the most infusible. They have more than any other metals the power of occluding oxygen.

The first members of each series of this group form acidifying oxides, of the form RO_4, easily reduced to lower

s, of which there are several; while the following mem-
mbine with less oxygen as the atomic weight increases,
hird members do not give higher oxides than RO_2 or
They give stable alkaline double cyanides, of which
stalline specimens are exhibited to-night.

The first members give - - -	$K_4 R Cy_6$
The second - - - - - -	$K_3 R Cy_6$
The third - - - - - -	$K_2 R Cy_4$
And the members which form a link with Group I. give - - -	$K R Cy_2$

The propriety of placing the eighth group where it is will be recognised by every chemist when he reads the series thus:—

$$Cr=52;\ Mn=55;\ Fe=56;\ Co=59;\ Ni=59;\ Cu=63;\ Zn=65.$$

Amongst the specimens exhibited there are crystals Strontium Acetate Sr $(CHO_2)_2\ 2\,H_2O$ which crystallise in the Rhombic system, also the same salt with Copper replacing part of the Strontium, which is monoclinic, showing that Copper is not isomorphous with Strontium, although both are Dyads according to the old classification. On the other hand, you will observe the salts $2\,K\,Cl, Cu\,Cl_2$ and $2\,KCl, Pd\,Cl_2$, both crystallised in tetragonal crystals.

The first group contains the metals of the alkalies; they are lighter than water, and those which have the highest atomic weight form the strongest bases. The metals of Group IV., which form sub-oxides R_2O, are attached to this group by some of their characters only.

The second group includes the alkaline earth metals and their analogues, and again the basic power increases with the atomic weight.

The third group contains many elements which are little known; but we know that Thallium and Indium form

oxides which are stronger bases than Alumina, and which do not so readily play the part of an acid as Alumina does in the spinel ruby, $Mg\,Al_2\,O_4$, Gahnite $Zn\,Al_2\,O_4$, and Chrysoberyl $G\,Al_2\,O_4$.

Yttrium, which Mendeleef placed provisionally in this group, and which has been proved by further researches to be rightly so placed, forms a stronger base than Boron does. This latter element forms a distinct acid, $H_2B_2O_4$, and its basic character is seen only in an obscure sulphate and in a phosphate analagous to the phosphate of Aluminia $B^{III}\,PO_4$.

The fourth group forms both bases and acids; but Thallium and Lead form stronger bases than Zirconium and Tin, while the lower members yield the most distinctly acid compounds, Carbonic acid, Silicic acid, Titanic acid and Stannic acid. The affinity for hydrogen appears to decrease with the atomic weight. CH_4 is a stable though combustible ingredient in coal gas. $Si\,H_4$ is so unstable as to be spontaneously inflammable, while hydrogen compounds of the higher members, $Zr\,H_4$, etc., are unknown.

In the fifth group all the members form acids, the acidity of the compound decreasing as the atomic weight of the element increases; while oxide of Bismuth is a stronger base than oxide of Antimony.

In Group VI. the acid-forming power decreases as the atomic weight increases.

In all the series the elements with the higher atomic weights are more easily reduced from their compounds and obtained in the free state than those with lower atomic weights. In Group II. the volatility increases with the atomic weight; but in other groups this rule is not observed. In Group VII., on the other hand, the volatility decreases as the atomic weight increases. Chlorine is a gas at the ordinary temperature = Bromine is a very volatile liquid,

while Iodine is a grey solid, forming a violet vapour only when heated.

The melting point of an element does not depend upon the weight of its atom so much as upon the number of atoms in a molecule.

The value and importance of any new generalisation in science are measured :—

1st. By the number and variety of facts which it includes in one general expression.

2nd. By the manner and degree in which it explains and correlates old facts and predicts new ones.

3rd. By the impulse which it gives to research, and its fruitfulness in new discoveries.

1. It has been possible only to indicate in a very sketchy way in a single evening, and to a non-chemical audience, the kind of facts which are generalised by Mendeleef's Periodic Law; and I shall only say further that the more one studies the facts of chemical science in the light of this law, the more fully does one become convinced that a great truth underlies it, which we may one day be able to understand, and which will account for the law. Nothing equal to it in importance has been added to Chemical Philosophy since Dalton's Atomic Theory and the Law of Substitution; and it at once supersedes the atomicity grouping, inasmuch as the latter subordinated everything to an apparently arbitrary relationship depending upon properties attributed to unknown causes, while the Periodic Law asserts that the properties of the elementary atoms depend upon their mass.

2. On the second point, I shall only instance two or three cases of predictions made by Mendeleef which have been verified in a very remarkable way.

The Periodic Law indicates the existence of elements in the unoccupied positions between certain of the known

elements, having intermediate atomic weights, and properties which differ from those of the known elements in a certain way. For instance, there must be a metal intermediate in properties between Aluminum and Thallium, between Cadmium and Tin, and between Zinc and Lead, which forms an oxide of the form R_2O_3, a more distinct base than Alumina Al_2O_3; the atomic weight of this element must be between 112 and 118, or not far from 115. The atomic weight and properties of Indium were not known when this announcement was made, but when they were known, it was found that the properties of Indium were those indicated, and that the atomic weight is not much above 113.

Again, Mendeleef prophesied that a metal must exist occupying the place immediately below Aluminum, having the atomic weight about 68, which should bear the same relation to Aluminum that Zinc does to Magnesium; should form an oxide R_2O_3, which should be a stronger base than Alumina; should form a salt resembling Alum; and its specific gravity should be about 6.

A year or two ago, Lecocq Boisbaudran discovered in a zinc ore a metal which has precisely these properties, and whose specific gravity is 5·9. Its atomic weight was found to be 69. The actual fusing point of this metal could hardly have been even guessed.

In the group Mg, Zn, Cd, the fusibility increases with the atomic weight; in the groups S, Se, Te, and Cl, Br, I, the lower members are the more fusible; in the intermediate group Al, Ga, In, the middle term is the most fusible; for Gallium melts at the temperature of the hand.

One other instance. Mendeleef predicted an element next to Boron, with atomic weight about 44, which should have only one stable oxide R_2O_3, a stronger base than Alumina but weaker than Magnesia; a weaker base than Yttria, but greatly resembling it and difficult to separate

from it. The oxide should be insoluble in alkalies, and it was doubtful whether it would decompose Ammonium Chloride.* Its salts should be colourless and give gelatinous precipitates with Potash, and with Sodium Carbonate, and with Sodium Hyposulphite.

With Potassium Sulphate it should form a double salt, having the composition of Alum, but not quite isomorphous with it. Few of its salts should crystalise well. Water should decompose the chloride and evolve hydrochloric acid.

The oxide should be infusible, and soluble with difficulty in acids after ignition.

The specific gravity should be about 3·5.

One of the elements discovered last year, and named Scandium, has the specific gravity 3·8; it agrees in all the above details with the predicted properties,* and its atomic weight has been found to be 4·5.

After this we may hope that Chemistry will become one of the exact sciences.

3. No principle since the Law of Substitution is so well calculated to stimulate successful research.

(*a*) The instances above given show how it suggests the search for new elements, to complete the system, and aids in the search by indicating to some extent the probable sources, and the elements with which they are likely to be associated, and also by so far indicating their properties as to guide the investigator to the best methods for separating the unknown elements.

Mendeleef has predicted with equal precision the properties of the element having the atomic weight 72, and the position below Silicon and Titanium; he has indicated how the element can be isolated from some of its compounds when they are discovered; that its specific gravity will be

* Scandia does not decompose Ammonium Chloride.

about 5·5, and that of its oxide about 4·7; he expects that it will be found in a kind of rutile, and predicts many other details which time will not permit me to quote.

(b) It suggests the correction of some of the atomic weights, and aids in the determination of the atomic weights of elements hitherto undetermined.

Glucinum, a metal supposed to resemble Aluminum, and found in Beryl, Phenacite, etc., is an instance. The quantity of Glucinum equivalent to one atom of H is 4·7, so that if its oxide resembles Al_2O_3 it must have the atomic weight $3 \times 4{\cdot}7 = 14{\cdot}1$. But this atomic weight belongs to Nitrogen, an element having very different properties. The properties of Glucinum are more like those of Magnesium than Aluminum, and the atomic weight might be $2 \times 4{\cdot}7 = 9{\cdot}4$. Accordingly the whole subject has been investigated by different experimenters, and it is now found that the atomic weight is really 9·4, and the true position of Glucinum is above Magnesium and Calcium in Group II. In like manner the atomic weights and properties of Cerium, Lanthanum, Didymium, Yttrium, and others have been, or are being investigated, in consequence of the Periodic Law having indicated that the old atomic weights must be wrong.

Mendeleef placed La. above Thorium and Lead, with the atomic weight 180; but it appears that its atomic weight is really 139, and that its position is below Indium, where Mendeleef placed Didymium, while Di. has been found to have the atomic weight 144 to 147, and its place must be further on in the series. It is now pretty certain that Cerium should be placed below Zirconium and Tin. The positions of Erbium and some other elements are at present uncertain.

(c) It stimulates us to enlarge our knowledge of the forms and properties of chemical compounds, by indicating a great variety of hitherto unsuspected resemblances between

elements occupying neighbouring positions on the spiral table.

(*d*) While the Periodic Law suggests the correction of some atomic weights, such as Tellurium 125 for 128, Yttrium 88 for 92, Osmium, Iridium, etc., it is to be observed that the differences between the consecutive members of the several series are not exactly uniform, or, in other words, the atomic weights of very many of the elements are not exactly what we should expect them to be.

We might explain away these discrepancies by supposing that the atomic weights have not been quite accurately determined, and it is admitted that the exact determination of any atomic weight is a matter of the greatest difficulty; but it is not necessary to take refuge in any such special pleading.

Mendeleef adopts a much more philosophical argument, and candidly accepting as facts the slight variations from uniformity in the increments of atomic weight observed, he reasons thus: If there is a slight irregularity in the increments of the atomic weights, the reciprocal relations between the properties of the elements ought to be modified in a correspondingly slight degree; and accordingly we do find that the periodic modification of the properties is not rigidly uniform, just as the increment of atomic weight is not always arithmetically exact. And thus in these slight special irregularities, as well as in the general regularity, we find evidence of the truth of the law of dependence of the properties of the chemical elements upon the weight or mass of their atoms.

LIFE-HISTORIES AND THEIR LESSONS. A DEFENCE OF THE UNIFORMITY AND STABILITY OF VITAL PROCESSES AS CONTROLLED BY THE LAWS OF EVOLUTION.

By Rev. W. H. DALLINGER, F.R.S., F.R.M.S.

This paper is extremely simple in its aim. It was written (with no intention to publish) at the request and in the interests of a large number of microscopists and amateur students of the phenomena of life as seen in the flora and fauna of our ponds, ditches, and sea-side, as well as in septic fluids. Some industrious observers amongst them had, from a desultory method of observation, of necessity, met with paradoxical phenomena. The products of pond and ditch were placed for an indefinite time in "live boxes," kept as long as possible from evaporation. The results were the inevitable commingling of life and death; the destruction or decomposition of one set of forms providing nidus and pabulum for quite another. In all probability the life-histories of none were really known, and parasite, epiphyte and septic organisms succeeded, or were concurrent with, each other. The possibility of erroneous interpretation in such a case is immense, specially when the "observation" is broken and occasional. The result has been, that ardent minds have endeavoured to show that some of the issues observed were only to be accounted for on the hypothesis of "Heterogenesis."

Some of the cases appeared striking; and at the instance of a large number, who thought good service might be rendered by it, I have taken a series of similar or corresponding instances to interpret the anomalies, and show

that "Heterogenesis" is no part of the phenomena of minute life when studied with sufficient care and continuity. It is in deference alone to the strongly-urged request of these that the discourse is printed.

We have frequently, during the past few years, at the Microscopical Society of Liverpool, and more recently elsewhere, had our attention called to apparent anomalies in minute organic forms and minute organic processes. In these, besides the portraiture of what were considered the "facts," there has been an attempt made to show that along the border and margin where life manifests itself on this earth, amongst its minutest developments and least organised products, there is uncertainty of developmental action:—either no law at all, or if there be law, that we are wholly without knowledge as to its character; and that it must be unlike the laws which we know are in constant and unvarying operation where our knowledge of vital processes is absolute and complete.

Now, it must be remembered that by the modern microscope a realm of life and organisation is opened up to us almost infinite in its extent and variety; and increased optical power, instead of exhausting, only widens out, intensifies, and renders it more entrancing. But as it required the aid of moderate lenses to understand exhaustively the mode of life and methods of growth of an oak-tree—large as it is—so it must require the magnifying power of our most perfect and powerful object-glasses to discover the modes of life, methods of metamorphosis, and manner of origin, of the immeasurably lesser forms, which are not seen at all, until the lens needful to discover the germination of an oak tree is used. As we pass downward, we come to less and still lesser forms, all equally endowed for, and adapted to, their environments. But as we come to the more and the most minute of the organic forms

in nature at present discoverable by us, we come upon forms that multiply with an inconceivable rapidity; many of them will, by one process of multiplication alone, produce, in the course of three hours, as many individuals as there are at present human inhabitants on the surface of this earth; and in a paper read only a few days ago in the French Academy of Science, M. Pasteur, proposing to destroy Phylloxera by fungoid growths, said: "The extraordinary multiplication of Phylloxera is a mere trifle compared with the power of life and propagation of certain parasites. The Hall of the Academy of Science . . . is pretty large: it has hundreds of cubic metres of capacity. I would undertake," said Pasteur, "to fill it with a liquid of such a nature, that by sowing in it a microscopic organism, the whole of the immense vessel would in a few hours be troubled with the presence of the parasite, and in such great abundance, that all the *phylloxeras* in the world, compared in numbers to the individuals of the parasite, would be like a drop of water in the sea" But their *modes* of multiplication, in their completeness, are either defiantly beyond our present powers of research, or if here and there known at all, they have to be very patiently, persistently, and with the highest powers of the microscope, worked out.

Now, whoever engages in this work will learn many things indicative of caution, and will be slow indeed to make hasty inferences.

There happens to be, however, a fine army of such workers in the world just now; men who, with all the necessary mental endowments and training, are, with the most splendid lenses the world can produce, working amongst the mazes of this wonderful margin and edge of living things. They are trying to individualise the components of the apparently confused mass, and make out the life-histories of these minutest of living things. And they are slowly succeeding. Life-history after life-history is being drawn by resolve and

patience from the depths of the confusion :—and with what result? Everywhere, where the work has been exhaustively done, with the affirmation that Biological processes amongst the least and lowest living things are as orderly rigid, and within certain limits, as capable of predication, as amongst the Butterflies or the Entomostraca.

Here are men, forever working amongst forms of life, similar to, or identical with, those brought before us in the papers the inferences of which I seek to controvert. But they use far higher magnifying power, and pursue another method of research essentially exact; do they reach like results? Do they infer that one form of minute life may transform itself into another? That the protoplasm from a cell of Chara or Nitella may become, of its own caprice, or by some hidden law, and without the intervention of parent or egg, a Paramæcian?

Verily, no! The testimony of Balbiani, Pasteur, Van Beneden, Bütchli, Fol, Hæckel, Huxley, Pelletan, Asa Gray, Louis Agassiz, H. J. Clarke, W. Roberts, Balfour, Ray Lankester, Ewart, and a host of others is *unanimous*—and it is this—that wherever we work out a minute life-history thoroughly, we come upon as orderly a process of nature as in the development of a frog or the growth, from its fertilised germ, of a primrose.

All this of course is no reason why others should *not* find what *is*, or what *seems to be*, uncertainty or caprice in the lower strata of vital action in nature. Only that they *should* do so, implies a method of research either inconceivably higher, and more analytical, than that adopted by these leaders of research in minute Biology; or else it can be explained as *error* arising from a method not competent to cope with the conditions of the problem.

Approach the question of vital action as displayed by Protoplasm fairly. What is that in nature which, above all

things, impresses us as we study the phœnomena, and the results of her countless cycles of activity? The stability of her processes; and the mathematical precision of her action. Does anyone doubt the invariable and inviolable nature of the laws that control chemical combination and physical phœnomena? Would any amount of paradox or perplexity that might arise in complex experiment induce a man to believe that the proportions of carbon and oxygen which constitute carbonic acid are uncertain and capricious? or that the combining proportion of oxygen and hydrogen are very uncertain in the synthetic production of water?

If you heat a bar of platinum under certain fixed conditions, on two following days, you do not expect that it will indicate different powers of expansion, or melt at a lower temperature to-day than yesterday. A given musical note will depend on the same number of vibrations to-morrow as to-day.

Yes. But it may be said all this applies to the inorganic world. Is it true of that which lives? Properly understood, I profoundly believe it is.

What do we know of life? Only this with certainty:—that wherever you have life it is inherent in a definite compound. This compound has special and unique properties. But wherever you find it *as protoplasm* in the sense in which I use that word, it exhibits the properties of life, and you will nowhere find the properties of life except associated with, and inherent in, protoplasm.

Now, has this protoplasm an ascertainable composition? Yes; you can analyse it chemically—that is when it is *dead*—and it is found that its chemical elements are everywhere practically alike. To say that the life-stuff of the lowest fungus, and that of the most powerful human brain, are *identical*, is, there is no doubt in some sense, absurd; it is an abuse of language; they, without question, differ incon-

ceivably. But if you consider *only* the chemical composition, and discoverable physical properties of protoplasm from a mildew, or protoplasm from the apparatus of human thought, they are alike. Their difference is potential and not physically manifest.

Then we may ask, "How, and in what, do matter living and matter not living differ? In their *properties*—and in these they differ as the finite and the infinite differ—absólutely and wholly. We may not dwell upon what they are—Mr. Higgins did that a few weeks since. But we may add that even the chemical reactions of *living* protoplasm are quite different from those of the substance which represents the protoplasm, when its life is gone.

Professor Huxley writes concerning protoplasm thus:—"The properties of living matter distinguish it absolutely from all other kinds of things; and," he continues, "the present state of our knowledge furnishes us with no link between the living and the not living." *

Then, so far as the evidence will carry us, there is *to-day* in our laboratories, and in our facts from nature, *no evidence* of the existence of spontaneous generation—no phœnomena that prove, or even suggest, that what is not living can, without the intervention of living things, change itself into that which lives?

The masters of Biology agree that there are *none*. Only that which is living can produce that which shall live. Dissociated molecules of lifeless matter, with no vital affinity to marshal them, are, as a matter of fact, never seen to endow themselves with the properties of life.

Dealt with physically, it has, as a question, received masterly treatment at the hands of Tyndall, and his answer is emphatic—it is that that which is *not* living does not give rise to that which lives.

* *Ency. Brit.*, vol. iii., page 679, 9th ed.

Biologically, it has been dealt with by all the workers in minute Biology, and their answer is, That as far down as we can reach, or *see*, with certainty, living things arise ultimately in living products—parental germs or spores—the equivalents of eggs or seeds.

"But," says the shallow reasoner, "if there be no spontaneous generation in nature, how can we have consistency in the great doctrine of Evolution? *That* process must have been a march of mighty progression *from the beginning* until now." Evolution is in danger by your facts! I answer, if that *be* so, then I prefer the *facts*, to the doctrine of Evolution. But I affirm that such reasoning is wrong, and Professor Huxley shall give the answer. If *once*, in the mighty activities of the evolving past, dead matter was at some point of crisis and necessity *changed into* that which lived, and one of its properties was the capacity to multiply itself indefinitely, why do we need the *constant* change or transmutation of that which is dead into that which is living *to-day*.

Says Huxley, "If all living beings have been evolved from pre-existing forms of life, it is enough that a single particle of protoplasm should *once* have appeared on the globe, as the result of no matter what agency; in the eyes of a consistent evolutionist any further independent formation of protoplasm would be sheer waste." *

Then the facts are:—1. That protoplasm or "bioplasm" is a certain definite compound possessing the *properties of life*.

2. That life is nowhere found without it.

3. That only living matter can produce living matter.

Now, I ask, Do the stability and precision discoverable in the operation of chemical and physical law, as applied to not-living substances, hold good in the operation of the discoverable laws of Biology? I maintain that they do.

* *Ency. Brit.* vol. iii., p. 689.

One error often entering into a discussion of matters concerning protoplasm, is to suppose that we are discussing *an abstract thing*. Who ever saw abstract protoplasm? There is no such thing. You may have the protoplasm of an alga, or of a trout, or of a man; but you cannot have protoplasm that belongs to nothing. As there is no abstract *matter* discoverable by us, so there is no abstract protoplasm. You may have matter endowed permanently with the properties of gold, or silver, or hydrogen; but the matter common to and underlying them all is not discoverable.

You must therefore, if you have matter at all, have it specialised, endowed with certain properties.

It is so with protoplasm. It is never within our reach as an unspecialised compound. We know it as the protoplasm of a mushroom, or an oak tree, or an amœba, or a sparrow, and *therefore* with the special properties belonging to that and to nothing else.

Living stuff is the product of living things. Living things are developed according to known and discoverable laws, as rigid as those which determine the composition of carbonic acid or chloride of sodium, only more complex.

All the living things with which we are acquainted originate in an egg, or a seed, or their equivalents; or else in the multiplication of forms already existing, by fission.

But are not the processes of multiplication rigid and determinate? Take a group of primitive ova. Let them represent forms so diverse as the Stentor, the Daphnia, the Trout, the Rabbit, the Pig, and Man. Physically, chemically, optically, they are alike: the severest effort and most rigid scrutiny can discover no essential difference between them. But is there no difference? Nothing can be more inconceivably diverse than the possibilities that are enfolded in those germs. But no one supposes that they will either of them be recreant to their mission and do the work of the other!

Is it conceivable that the stentor could hatch out into a trout, or that the trout ovum could perchance produce a rabbit? No; these eggs have their laws as much as the molecules of carbon or of chlorine.

But, say my opponents, it is of the protoplasm of the cells of living things, not of the mission of the egg, that we argue.

And what, I would ask, is the protoplasm of the cell but the outcome and product of the egg? And what is the whole economy of organisation but the specialised function of grouped cells? A sponge is a bundle of living cells with varying but mutually adapted endowments. So is a man. Every animal is, in fact, a perfect commonwealth of cells adapted and endowed each for its work, and all adjusted to each other.

What is the primitive seed but a cell endowed with a potentiality to give origin to other cells, beautifully grouped together, to constitute a mussel or a man?

Then why should the protoplasm of individual cells go astray, and become capricious, any more than the egg from which they sprang, and from which they became possessed of their peculiar and inherited qualities? True, it is now an established fact in biology that the products of eggs are never precisely alike. There may even be deformity, but this is exception, and may, in the course of time, be reduced to law. But always there is variation, and if that variation be for the benefit of the organism, it will survive and be perpetuated. But there are no leaps—there is no caprice. The egg of a linnet will not produce a grasshopper, or that of a trout a butterfly. And if there were not equal certainity that the cells begotten by the egg were equally true to their mission, and loyal to each other, as the egg-cell was true to its work, could organic life exist at all? It seems impossible.

But there are certain phœnomena in the protoplasm of

cells which, if not understood, may lead to the profoundest error. This especially amongst the lowlier forms of life.

Protoplasm is soft and plastic, varying in consistence, but it is never a fluid proper. It defies the laws of fluids; and one of the things common to it in the lowlier forms of plant-life especially, is circulation or cyclosis within the cell.

To illustrate this we may take an illustration placed at our disposal, viz., the stellate hair from a bud of *Althaea rosea*. In this minute vegetable growth the circulation of the protoplasm is clear and beautiful. The course of the stream being clearly visible. Now, suddenly *rupture* these cells, the protoplasm is at once set at liberty, but is not dead; and, consequently, it creeps about like a living amœba for minutes, or possibly for hours.

The wonderful movements of the naked protoplasmic bodies of *Myxomycetes* are known to every careful botanist.

But put some *Vaucheria* into a live-box, and let it slowly, as it must do, decompose and die. The plasmodia does its dying slowly; but the sacs are ruptured by decomposition—and what happens? Here (Plate I, Fig. 1) is an illustration directly from life in two cases. At *a* the protoplasm has emerged from the cell, carrying a clear globule with it, and then, after a few moments of amœboid movement, became a walled cell and granules, as may be seen at *b*.

In the other instance, shown by *c*, the protoplasmic contents broke off from the cell, and became free, like an amœba. In its free state it is shown at *d*. This drawing is a facsimile of it as it appeared at an interval of four minutes. The outline shows, in fact, its shape four minutes before. And this movement continued for two and a half hours, and then both pieces of plasma died and dissolved.

What was this? a change in the mission of the vaucheria protoplasm? No; only the pertinacity of the life that was in it, with its necessary properties.

PLATE I.

FIG. 1

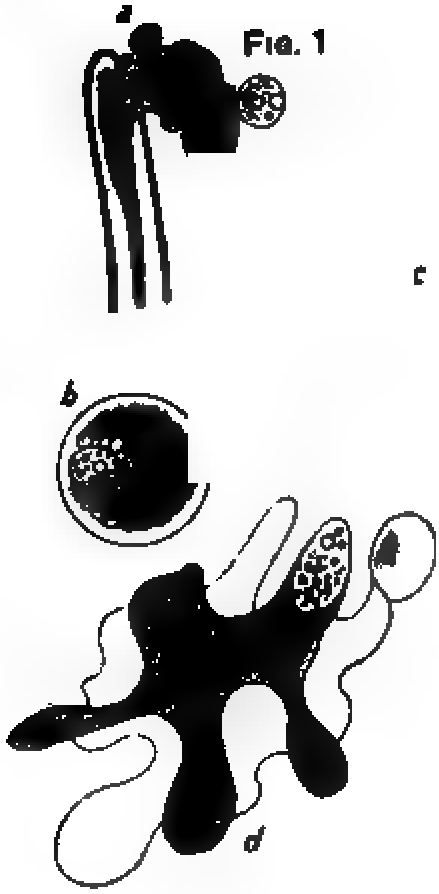


FIG. 2

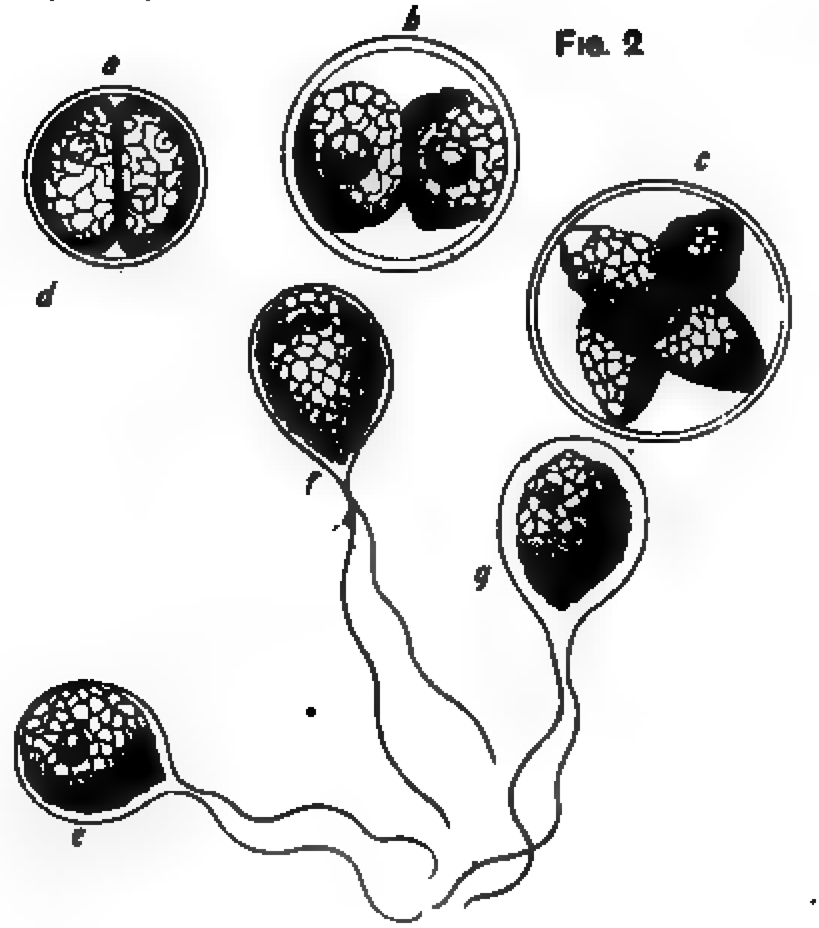
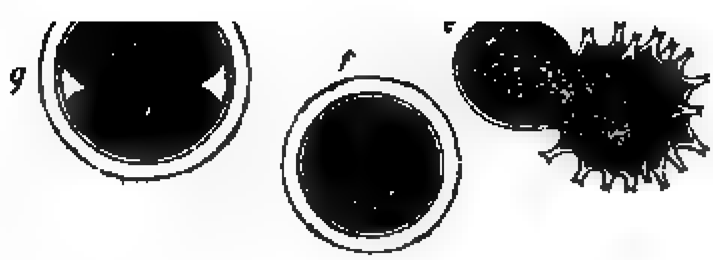


FIG. 3

FIG. 4



And let it be observed this is by no means a rare incident. It is one of the common facts of botanical physiology.

I shall serve the end I have in view, then, if I ask you now to permit me to glance at two or three of the lowliest life-histories in nature, to see whether they—where we know them well—indicate uncertainty or suggest caprice.

I begin with one of the simplest and lowest algæ known in Nature, *Protococcus pluvialis*, and I deal with it in its simplest condition, *i.e.*, the resting and the motile states of the green unicellular plant.

The history I give has been long known, and has been confirmed by many, but the drawings I give have been verified from nature, and the objects are magnified 1,000 diameters.

The whole plant is a microscopic globule. In its "still" condition it is a delicate globe, transparent, but filled with a reddish yellow granular mass; if not seen to be at first constricted centrally, it quickly becomes so, as in Fig. 2 *a*, and each part contains a nucleus, as the drawing shows. It soon increases in size, as in *b*, the nuclei enlarging and the area of the envelope becoming much extended; at this time the colour of the granular mass changes into greenish, and then distinctly green; but the nuclei become almost colourless. Cross division now ensues, as in *c*, which may go on until sixteen or more cells are seen to be formed within the hyaline envelope. Soon the cells separate and fine vibratile lashes or flagella show themselves (shown for the sake of clearness only in two instances in Fig. 2 *d*.) The envelope now opens, and these flagellate globules go free; but a nucleus manifests itself, as is seen in *e*, which is shortly seen to be undergoing constriction, as at *f*. This speedily divides into two, as in *g*, then the flagella fall off, the hyaline envelope becomes more manifest, the little organism is perfectly at rest, and soon assumes the condition seen at *a*, with which the cycle begins again.

Observe, then, that although this process is so simple as to be immeasurably below those that come immediately above it, there is no caprice, no unformulated phœnomena, and yet this may be observed for weeks, or even months together.

Only clearly remember, this is the observed phœnomena in the living and normal plant. Let, however, a mass of dead protococci accumulate in trough or live-box, mingled with living ones, and all the complex issues of decomposition immediately arise.

Proceed now a step higher. We are still with the lowly algæ, and I select a *Desmid*. With the group you are mostly, doubtless, familiar. They are minute but elegant plants, consisting of isolated cells, which live in every pond, ditch and streamlet on the surface of the earth. They are exquisitely minute, with delicate grace of form and beauty of colour. They are amongst the lowliest of living things. How do they multiply? and in the life-history of these delicate cells is there irregularity, uncertainty, or caprice? No; there is no discoverable departure from the secular process formulated by the great Darwinian law. They increase immensely by cell multiplication, which in one section of the conjugatæ remain united in long embranched threads of remarkable beauty. But the form of desmid, known as *Cosmarium Botrytis*, has been sufficiently worked out by De Bary to serve as an excellent type. The cell is symetrically bisected by a deep constriction, as in Plate I, Fig. 3 *a*, but soon the narrowest part of this constriction elongates, then widens laterally, as in *b*. This new process rapidly widens, lengthens, and takes the required form, until, as *c*, *d*, *e* indicate, the one cell has become two, which are in all respects perfect, and, freed from each other, rapidly repeat again this process.

This goes on for an indefinite length of time, but it cannot go on for ever. It exhausts the vital capacity of the plant; there must be regeneration, the beginning of the cycle afresh.

To this end, two of these elegant cells, placed together, and stimulated by what we have no means at present of discovering, open their cell walls and pour out their contents, which meet, as seen in Fig. 4 *a*, and fuse wholly together, deserting the original coverings, which are left empty beside the mass, as in *b*, *c*. The mass now rapidly becomes spherical, forms a triple cell wall, and pushes out spinous growths, seen in *d*. The wall of the spine sphere now opens and sets free small spheres of sarcode, as in *e*. The history of each of these is the growth from it of two new cosmaria. A gelatinous wall forms, as in *f*, and a constriction of the contained sarcode is soon visible, which increases, as in *g*. Then each constricted half again constricts, and becomes again a symetrically divided cosmarium cell, as seen in *h*. The mother cell wall is then absorbed, and the new cells separate from one another, and are free.

With competent powers, patience, and a continuous non-evaporating stage, supplied with Cosmarium Botrytis in vigorous vitality, this may be confirmed by any careful and competent observer. But he who supposes it can be done when the cosmaria are mingled in a cell with decomposing vegetable forms from a hundred other sources, present in the cell, giving rise to the production of the septic organisms on the one hand, and a variety of epiphytic forms of algæ, with all their complex, and in many cases unknown, modes of development on the other, is wholly and absolutely mistaken. But let the life-history of this form, by itself, be thus carefully followed, and it will be seen to be from a biological view as rigidly, according to law, as that which in physics is known to be the determining cause of a lightning flash or the production of an oxide of iron.

But we may advance one step further. The confervoid algæ are quite well known to the students of the pond and stream, and the thallus of the vaucheria is not unfamiliar

amongst them. Now, it is well known that this lowly plant multiplies in two ways, but the distinctly genetic character of the one is more marked than in the preceding case; it is brought about by the formation upon the branches of the vaucheria of female cells (oögonia) and male cells (antheridia). These grow very near to each other, and in the antheridia are formed spermatozoids, while the contents of the oögonia are transformed into an oosphere. The oogonium and the antheridium open simultaneously, and the spermatozoids enter and are lost in the contents of the oogonium which is thus fertilized, giving rise again to the plant.

The asexual mode of reproduction is quite simple, but quite regular. The growing end of the thallus becomes clubbed and filled with brown granular contents; these shrink, becoming brown in colour, and force their way through the ends of the thallus, as a gonidium, which, on escaping, is found to be ciliated, to swim freely, and ultimately to settle and give rise to new plants.

We have here a lowly plant indeed; but, none the less, we have remarkably specialised function and efficient differentiation. All this is palpably subservient to the reproduction of the plant, its multiplication and continuity. How did all these complex apparatus and adaptations arise? Only by the slow operation of the Darwinian law—the conservation of ever-recurrent beneficial adaptations. But if the non-sequential attempts at deduction such as our attention has been frequently called to, could be taken as sound, if a Desmid, or Diatom, or a Paramæcian, or a Rotifer may by one capricious bound, or freak of nature, be produced directly, and without its parental product—the egg or its equivalent—from the decomposing cell-contents of (say) Chara or Nitella,—why did nature spend what to us must appear as its truly awful energies on the production of processes so complex and wonderful as we

have seen them, even in the lowly algæ, to be; intended as they manifestly are only for the preservation and multiplication of the special forms? Heredity, known to be so powerful a factor in biological processes, would thus have no place. There can be no "survival of the fittest," for the Paramæcian coming by no conceivable method out of the decomposing "protoplasm" of an alga, need have no "struggle" for existence, but having done its little life-work, may, in decomposing, give rise thereby to—a Rotifer!

The absurdity of this position seems only to require to be shown to be admitted. To assert it of the larger forms of life would to the least observant be to excite a smile. No one supposes that a grasshopper's egg will give rise to a "painted lady," or that the decaying sheep upon the moor, because there is life upon it, has had the life that it has, as an organism, lost, transformed directly and without the intervention of other life-forms into the living things it harbours and sustains. No; it is only because we are amongst the minute and unknown that the idea of heterogenesis is capable of being for a moment entertained; and here it vanishes as our knowledge of the forms involved becomes more clear.

To know the life-history of any organism we must study that; we must separate it from the crowd of other forms amidst which it flourishes, especially if amongst these there are organisms whose developmental history is not clearly known. Then observation should be continuous, not broken. Sequence in morphological development can only be certainly made out by unbroken observation. Therefore, to do as some of our local observers have done, put Chara nitella, Vaucheria, or Desmids into a "live-box" with water, and keep them in a moist cell, and take them out for an hour's observation to-day, and a couple or three hours' observation to-morrow, and because different phœnomena present themselves, suppose them to be developmental sequences, is full of potential and actual error.

The algæ alone have hundreds of epiphytic algæ parasitic upon and within them, whose life-histories are at present entirely unknown to us, and therefore, as the plants themselves slowly decompose, we must of necessity become lost amidst the mazes of the mingled life and decomposition into which we are looking.

Mr. Archer, of Dublin, a distinguished algologist, referring incidentally to these, says that they "are numerous and of common occurrence; but the scientific world may not even yet possibly be aware of the newest 'facts' put forward by Dr. Bastian, as to their nature and origin (*Beginnings of Life*), who explains all in the most off-hand manner by gravely assuming that the varied and often very heterogeneous epiphytic *fringes* of algal forms which are met with attached to higher plants, are developed as merely *heterogenetic* outgrowths from the latter!"

But in attempting hastily to make inferences in favour of heterogenesis, still more glaring proofs of ignorance may show themselves.

Amongst the lowliest of the fungi are the group *Saprolegniæ*. The parasites composing it were until recently known as being chiefly confined to the bodies of insects, as flies, spiders, &c., in water. They are now, however, known to infest the fish that inhabit our rivers, and are the actual cause of the "salmon disease" recently so prevalent in England. As a group it is closely allied to the *Peronosporæ*, of which the fungus producing the European potatoe disease is a conspicuous example. For a long time both these groups baffled endeavour to decipher them, but at length Worthington Smith and Berkeley have succeeded in working through the life-cycle of the *Perenospora infestans*, or potato fungus; and De Bary has made out the history of a *Saprolegnia*, or, as he prefers to call it, *Achlya*. But lôwly as these forms are, the cycle of their history is as rigid along inherited lines,

PLATE II

and by means of specifically specialised function, as are those of an *Agaricus* or a rose. De Bary finds that *Achlya prolifera* is reproduced by alternate methods like vaucheria. The asexual spores accumulate rapidly at the apex of the thallus, which ultimately bursts, and sends the spores forth by thousands, possessed of cilia and motile power, to germinate and grow.

But the ultimate preservation of the vitality in the plant depends, as ever, upon fertilised spores. The process is seen in Plate II., Fig. 5, which is a thread of the thallus. *a* is a branchlet, bearing a sac-shaped cell, in which the protoplasm collects and swells into a globular form, *b*, while arms at *d*, *c* begin to show themselves. Soon a septum forms, as at *e*, making the cell separate; the antheridium tubes, *f*, *g*, are by this time lengthened and closely applied to the cell; the nuclei resulting within the cell now strongly contract, and after fertilisation by the antheridia, these surround themselves with a cell-wall. An illustration from Cornu of *Achlya racemosa* shows, at *h*, *i*, the separated cell or oogonium, and at *m* the action on this of the antheridia tubes is manifest. The same is seen at *n*, *o* in another illustration; but is more delicately shown by De Bary by the combined action of the antheridia and the oogonium of Peronospora, as at *k*, *l*.

Now the speciality of this case, in my illustrative evidence of the fallacy of the attempt made by some amongst us whose industry we respect, to establish evidence of "Heterogenesis," from their observations is this, viz., that it enables me to point out one source of the error of inference; that is, want of knowledge of the life-histories of the forms from which inferences are made. One of the illustrations placed before this society in "proof" of the heterogenetic origin of living things was what was called a saprolegnia growing on the body of a dead fly in water. The fly had been attacked by fungus on a window pane and died. It was put into water

and the result watched. Without doubt Mr. Berkeley would have anticipated the result, but it was not so in this case. The saprolegnia grew apace, spread in all directions, and soon there arose *visible circulation of protoplasm* within the thallus, and minute granules were carried in the stream.

The inference made from this was, that the "protoplasm" of the *dead* fly's leg, had directly changed itself into the protoplasm of the saprolegnia, and was in visible circulation there.

But for the persistence with which this "heterogenetic fact" has been presented both at the Microscopical Society of Liverpool and at this Society, it would seem needless to repeat the facts; but in the interests of the younger students and workers it is needful.

Originally this fungus, which attacks the fly in air, was called by Cohn, *Empusa Muscæ.* By Fries it was called *Sporendonema Muscæ*, and afterwards *Saprolegnia ferox.* But it has been shown more recently, by the work of Cienkowski, De Bary, and Berkeley, that this aërial fungus, so common on flies in the autumn, is only a terrestrial and imperfect condition of an *Achlya* known as *Prolifera*, and which in an early aquatic state is shown slightly magnified in Plate II., Fig. 6. "This plant forms resting spores like Vaucheria; and there is every probability that they are generated by a like sexual process. They may remain unchanged for a long time in water when no appropriate *nidus* exists for them; but will quickly germinate if a dead insect or other suitable object is thrown in." "The tubes contain a colourless, slightly-granular protoplasm, the particles of which are seen to move slowly in streams along the walls as in chara, the currents anastomosing with each other." *

Berkeley also tells us that Achlya is an aquatic form of *Sporendonema muscæ;* that the filaments are devoid of septa,

* *The Microscope*, by Dr. Carpenter, pp. 356, 355.

and that the tubes contain a colourless granular protoplasm, denser on the walls, and that there is an irregular spiral movement in anastomosing currents exhibiting the circulation of the cell contents, such as is met with in hairs of Tradescantia.

In truth, then, what has been presented to us as a remarkable transformation of the " protoplasm of the dead fly's leg " into this circulating protoplasm of a Saprolegnia, was neither true as an inference nor new as a fact, except to the gentleman who offered it as an evidence of the heterogenetic origin of living things. It is one of the commonest events of the autumn to see " dead flies on the window pane," and we need not wait even for this phœnomenon to get the *Achlya prolifera.* The aërial condition of the fungus need not precede it. Throw a few flies into water, and in a day or two many of them will be covered, in all probability, with Achlya.

In Plate II., Fig. 7, we see the manner of its growth upon the decaying leg of an insect. At *a* (out of its natural position on the thread, for the convenience of illustration) is seen the sexual mode of increase, *a* being the oogonium and *b c* the antheridia. The method of asexual reproduction is seen in the same Plate, Fig. 8, where the end of the thallus, *a*, becomes densely packed with spores; a septum is formed at the base *b*, and ultimately the whole contents are poured out from the tip, as at *c*, as minute ovate spores, having one or two delicate flagella, as seen in a more magnified spore at *d*, which, like Bacteria or Monads, have the power of free movement. Soon, however, they settle on a suitable and exciting substance, as the dead body of an insect, or the living body of a fish or newt, and rapidly germinate, as at *e*, *f*, *g*. The manner of cyclosis of the protoplasm in the tube of the thallus is seen at *h*.

It must be pointed out that want of knowledge of the life-history of this lowly form was the entire secret of its production as a case of Heterogenesis. The *facts observed*

were correct enough; but the other links that made the chain of which they were *only a part,* were unknown to the observer; and this is a fruitful source of "fact," such as is constantly offered for a similar end. By such a method of enquiry and research, the potato disease might well have been taken as the "transmutation" of the protoplasm of the potato into its blight! Indeed, heterogenetically, this was a far better case, for here we *have* (living) protoplasm to get the fungus transmuted from. But in the other case only the proximate elements of the protoplasm of the dead fly. As it is, however, both Aehlya and Perenospora are known to have definite histories, and to depend ultimately upon the production of what are the equivalents of genetic processes.

It would indeed, in the absence of accurate knowledge, be much more to the purpose to say that the mistletoe was the direct result of transmuted protoplasm from oak or apple tree that becomes its "host;" for verily it lives by the living matter provided for it. But the Botanist knows that the mistletoe grows from a fertilised seed. *Not* knowing the history of the Achlya, it is easy for the believer in Heterogenesis to take a blind leap over Nature's elaborate arrangements for its continuance and multiplication, and assume that it sprang, without a progenitor or a past, into direct existence from the protoplasm (?) of a dead fly!

This is not a *new* process of inference in the history of Biology. There was a time when every process that could not be explained as it was, was explained as it ought to be. It was gravely affirmed that ducks grew on trees, and elaborate drawings of the process are still in existence. We all know how hasty inference could account for the coming of the flesh-fly in the carcase of the dead sheep, by transformation. But gradually the illusiveness of this method of inference has become apparent. Biology to-day is as rigid a science as Physics in some of its methods: this precision has "laid" the

ghost of Heterogenesis. Life-processes are no more capricious than processes of crystallisation. The laws of Biology are laws as much as those of Chemistry. The lowliest and minutest forms which we have studied have a known history repeated (subject to the secular processes of the Darwinian law) in all their successors. There is no sudden caprice; and therefore Heterogenists are fain to congregate about the fringe of vital forms where our knowledge of life-history is not complete, and where the minutest forms are found. We never hear of either crustacean or insect, however small, "transmuting." The explanation is easy. Whenever we know the history of a living form, although we know that in the process of ages it *may* slowly change, and give rise not only to varities but to different "species" and genera, yet that its metamorphoses or developmental processes, as capable of observation in the life-time of a man, or a generation, will be as certain, as the reactions of a metal or an acid.

The strange position taken up by Dr. Bastian, in his *Beginnings of Life*, has warped and rendered futile the character and results of the work of more than one earnest worker, desirous of using a microscope in the interests of Biological Science in this city, during the past few years. Many may contribute facts who may not be masters of the doctrines of a science, at least in microscopical work. But when their judgments are warped by the affirmation by an apparent "authority," that they are to expect to find Heterogenesis, which is "defined" as "the origination of living beings more or less complex in organisation from other living units, wholly different from themselves, and having *no tendency to assume* or revert to the parental (?) type." *

This is, in brief, a sort of charter for the wholesale "explanation" of what we *do not understand* in the develop-

* *Beginnings of Life*, vol. i., p. 244.

ment of living forms, into a "fact" for Heterogenesis. There are caterpillars of large size that are found sometimes in England, but often in America, which are the "hosts" of scores of minute larvæ, which eat and grow upon the fat and non-vital parts of the host; in the majority of cases they at last attack the vital organs, killing the caterpillar, and then eating their way through the skin, as in Plate III., Fig. 9, and then weaving cocoons on the surface of their larval host, wait until they emerge from these as perfect flies. They do not, however, always kill their unwilling entertainer. Fig. 9 *a* is from a drawing, by an American observer, of the cocoons empty; and Fig. 9 *b* is a magnified cocoon.

Now, to deceive in this case is scarcely likely; we know, by the aid of popular literature, and in some instances of school boards, that this is the work of an Ichneumon fly. But a similar case amongst unknown *microscopic* forms might easily be translated into "palpable Heterogenesis."

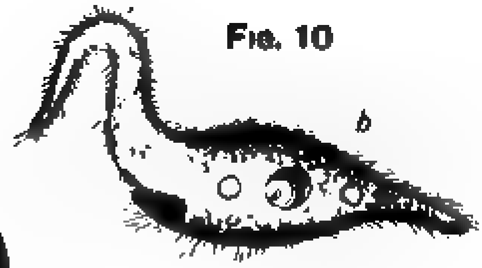
Not less remarkable, as a suggestive illustration, is that terrible internal scourge of man himself, *Trichina spiralis*. Every muscle of the body of a trichinised man or animal may be literally crowded with the delicate coiled "worm" at rest in its cyst. If we did not know that it had a history which, happily, is more or less completely compassed, could the thoughtful and practised Biologist conclude that it was the result of the direct transformation of the muscular protoplasm into Trichinæ? Perhaps some might; this has been done; but the microscope has come to our aid, and made us masters of the cycle of its life. But again it must be asked, if something equivalent to this happened amongst the medley of minute and lowly organisms that accumulate in a live box, or a trough, with decaying animal or vegetable matter, would not the heterogenetic bias be ready to infer "transmutation?"

Even more remarkable still are the curious parasitic fungi

PLATE III.

Fig. 9

Fig. 10



11 a

which attack and kill the larvæ and pupæ of insects. In the comparatively common case of *Hepialus virescens*, the caterpillar buries itself in the earth, and instead of becoming an imago, is absolutely converted into a vegetable—a fungus. The interior of the larva is wholly occupied with a white fibrous mycelium, and up through the very soil in which it is buried grows a tall fungoid filament, literally rooted in the larva itself. *Torrubia Robertsii, T. militaris, T. sphecocephala, T. entomorrhiza*, and others, are well known varieties of this fungus. This is decidedly a better case for inferring the "transmutation" direct of animal protoplasm into vegetable form, than many of the reputed cases in the *Beginnings of Life*, and others presented in this and other of our local scientific societies, of the transformation of Englenæ into Rotifers, or chlorophyll corpuscles into Paramæcia! But to patient effort it has been shown that these fungi have a definite biological cycle; that they arise in diffusable spores; and, within the terms of the known laws of Evolution, follow each generation the path of its predecessor as accurately as a sodium flame will give the same results to-day to the prisms and lenses of a spectroscope as it did under the same circumstances yesterday.

But from all this it will be seen that the danger in the case of the young and uninstructed student of pond life or putrefactive forms, is want of thoroughness or hasty inference.

In the year 1870, I actually watched a Paramæcian hatch or come out of what appeared to all intents and purposes an *encysted Vorticellan!* The Vorticellan was the beautiful form known as *Convallaria*. The Paramæcian was *Amphileptus anser*. This seemed an actual case of Heterogenesis. I paused, was silent, worked and waited. It was not until 1872 that a repetition of the phœnomena occurred; then it was rich in instruction.

A group of the *V. convallaria* was seen, as at *a, a, a,*

Plate III., Fig. 10. Swimming in the trough were several *Amphilepti*, as in Fig. 10 *b*. Suddenly an Amphileptus sprang upon and seized the crown of a Vorticellan, as at I *a*, Plate iii., Fig. 11. This little organism was powerless to shake it off, in spite of darting up and down, swaying to and fro, and the rapid lashing of its circle of cilia. Gradually it became less active, and a sort of fusion was manifest, as in II *a*, which was more and more marked passing through the stages seen in III *a* and IV *a*, until at length it fell upon the alga to which it was attached, as seen in *b b*, Fig. 12. This was watched, and at length there escaped from it the living form, roughly drawn at *c*, which passed through the stage *d* into the perfect form *a*, *anser*, shown at *e*. These drawings have been in my portfolio since August, 1872, when they were made, and I should almost entirely have forgotten it, but a friend, knowing of the incident, and reading Professor Huxley's *Anatomy of Invertebrated Animals*, just as it came out in 1877, called my attention to page 103, where we read, "Encystment, whether followed or not by division, is very common amongst all the ciliata, and a species of *Amphileptus* has been seen to swallow, or rather envelope, a stalked bell-animalcule, and then become encysted upon the stalk of its prey, just as *Vampyrella* becomes perched upon the stalk of the devoured *Gomphonema*." Thus an explanation of the seeming transmutation of Vorticellan into Paramæcian, and good evidence that it was not even uncommon, was forthcoming.

But amongst other illustrations of a similar kind, we were shown, recently, an instance of what it was contended was the emergence of a Paramæcian from chlorophyll granules in Nitella! The circulating granules in the decaying plant were said to have "become" an animal!

I can easily, from my own portfolio and that of others, produce similar instances. Fig. 13, Plate IV., shows some of the

PLATE IV.

Fig. 13

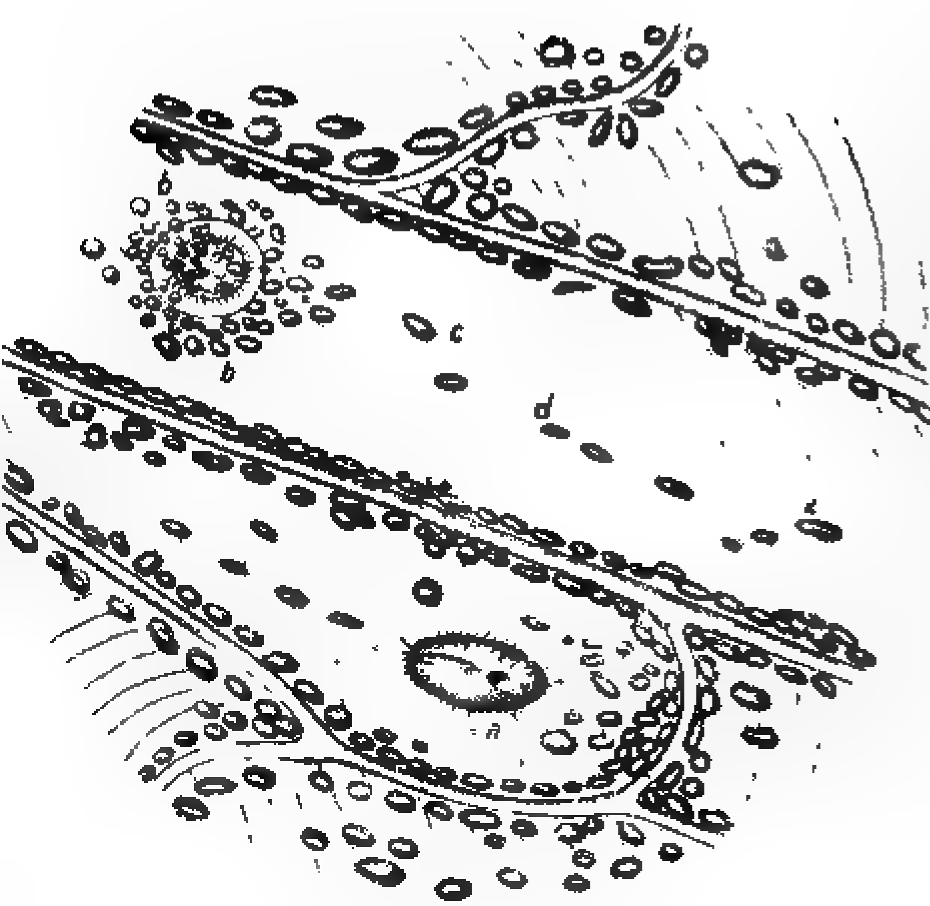


Fig. 14

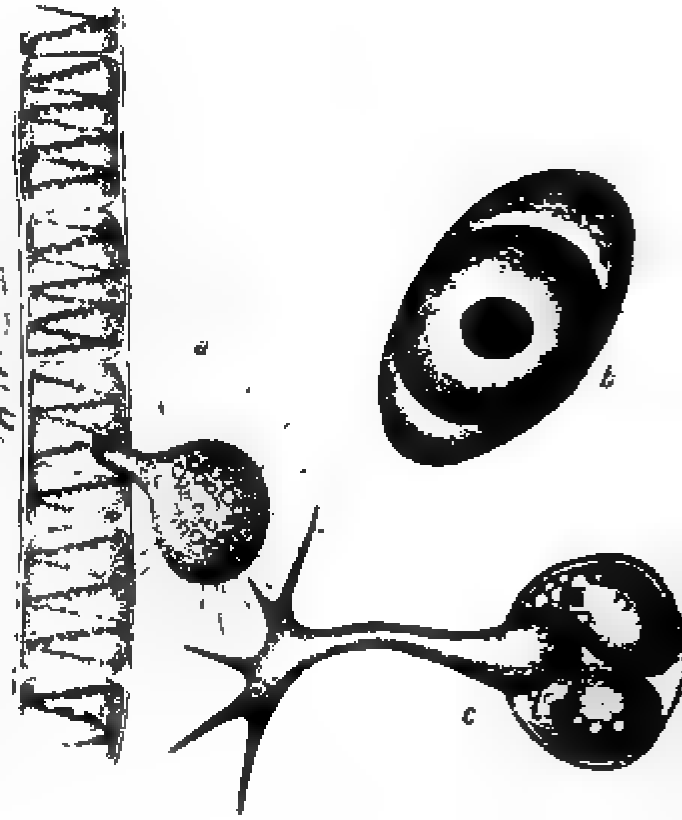
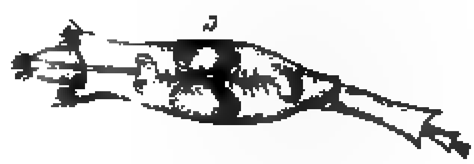
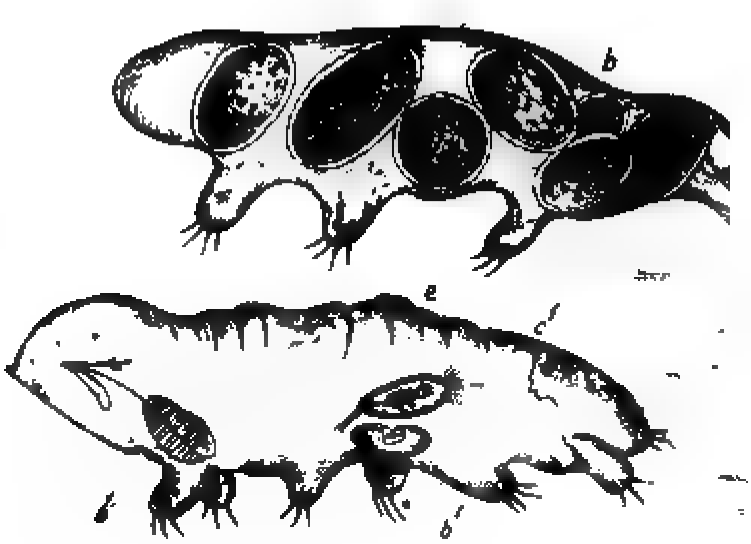


Fig. 15

Fig. 16





cells of a leaf of *Anacharis alsinastrum*, with their circulating chlorophyll granules. I have often seen, what is again and again recorded in treatises and monographs,—the presence of minute animals, as Paramæcia and Rotifers, within the cells of aquatic plants, as Vaucheria, Sphagnum, Nitella, and others. At *a* is an instance of this; the minute Paramæcian *Oxytrichia pellionella*, the 1-700 of an inch in length, was seen within the cell moving freely, and on being carefully followed was seen to "encyst," to become still and round in the midst of a cell, as at *b*. But we all know, who watch the cyclosis of particles within the cells of aquatic plants, that at times the granules get loose from the current, as at *c*, *d*, *e*, but as these flowed up they were stopped by the encysted animal, eventually covered, and at length, from the chlorophyll mound within the cell, an active Paramæcian wriggled and escaped, ultimately emerging altogether by the rupture of the cell-wall of the decaying leaf. The conjuror seems to take numberless eggs out of a burning candle. The mound of chlorophyl granules, taken as such, seems to change into a Paramæcian; in both cases it is not what it seems; it is something else to careful investigation.

It may be difficult to explain how these forms enter the cells of plants, but not more so than to explain how the spores of fungi enter eggs. Yet we know that this latter is true. But something may be learned from the observations of Cienkowski on *Vampyrella spirogyræ*, seen in Fig. 14; *a* is the mature form engaged in the work which distinguishes it, *i.e.*, boring into the cells of the spirogyra. It then withdraws its pseudopodia, is granular, and divides into three portions within a cell, *b*. These each escape, and become amœboid, as we see at *c*. Each of these again becomes at length encysted. Thus we have an amœba stage, a cell stage, a second amœba stage, and a final encysted stage.*

* Cienkowski. *Beiträge zur Kenntniss der Monaden. Schultze Archiv. fur Microscopische Anatomie.* Bd. i., 1865.

This is not a perfectly worked out form, but it has none the less in this relation a suggestive history as to its penetration of vegetable cells.

The same caution is necessary in reference to the occasional appearance of the accidental "grouping of chlorophyl grains." Something may be learned from the history of *Pediastrum granulatum*, the mother cells extruding granules in colourless (and at first almost invisible) envelopes, in an irregular manner; but these granules afterwards arrange themselves in their hereditary order, and become as their predecessors. But much by way of cautious investigation must also be added. Indeed, the lesson throughout is caution. Some illustrations, indeed, as many in this Society will remember, were given us from that admirable observer, Mr. H. Carter, F.R.S. These observations, however, which are very far from parallel with those adduced in comparison here, were made over twenty years ago. But since that time Mr. Carter has corrected, by further observations, what he discovered to be erroneous in his earlier results, explaining the paradoxes by the presence of parasites with whose existence he had not been before acquainted.*

We can only assume that this correction of the facts was unknown to the author of the paper which we criticise. Even Louis Agassiz, if we are only to allow his *earlier* work to bear witness uncorrected by his later, could be quoted as strongly on the side of Heterogenesis. Thirty years ago he asserted that the Trichodina was a Medusa! "In the eggs of Hydra he had been able to trace all the forms from the segmented yolk to these parasites; the fresh-water Hydra is the polypoid form of Medusæ, while these parasites are the medusoid form."† Further, he says, "I have seen a Planarian lay

* *Cf. Ann. of Nat. Hist.*, 2nd ser., vol. xix, p. 287, and *Ann. of Nat. Hist.*, 3rd ser., vol. viii, p. 289.

† *Proc. Boston Soc. of Nat. Hist.*, vol. iii. 1850, p. 354.

eggs out of which a Paramæcium was born (!), which underwent all the changes these animals are known to undergo up to the time of their contraction into a chrysalis (?) state, while *Opalina* is hatched from *Distoma* eggs." * And he further asserts that Colpoda and Paramecium "are the brood of Planariæ!" †

It is not difficult to explain these egregious errors of observation now. But it would be scarcely just to a distinguished, if philosophically narrow, Biologist, that these errors of the long past should be quoted as his latest judgments and most matured observations. It is not less a matter of moment that Mr. Carter's important emendations of his earlier observations should be noticed and receive their due weight.

I called attention some time ago to an interesting observation made by Mr. Chantrell on the Tardigrades.‡ It will be instructive to quote from this. "Most microscopists have at some time made the acquaintance with the water-bears of the ponds, and a good many have followed their development. Whoever has done the latter has fully convinced himself of the truth of the statements of Hölliker, Frey, Doyère, Kaufmann, and others, that the tardigrades in every instance produce large fecundated eggs, from which young, closely resembling the parents, emerge. Another feature of the tardigrades is the extreme hardness and toughness of their 'skin.' It is, in point of fact, speaking relatively to the Arthropoda, almost a 'shell.' This skin, it is also well known, is 'cast' by the creature, and it forms, in the case of the female, a shelter or protection for her eggs.

"Now, Dr. Bastian tells us that the power of reproduction

* *Essay on Classification*, Boston, 1857, p. 182.

in these forms is not limited to the 'rudimentary generative organ,' because 'Dr. Gros tells us that the dead tardigrades may ultimately be resolved into specimens of Actinophrys, Perammata, or Arcellinæ,' and that these products may at different times be either all of one kind or intermixed with each other and with young tardigrades! On the strength of this discovery we are presented with a drawing, which I reproduce. (Fig. 15 *a*.) The subscription which accompanies this is very suggestive. It runs thus, viz.:—'Seven large germs, into which the total internal substance of the parent has become resolved, each of them being capable of developing into a tardigrade.' Now, wherever there are plenty of tardigrades there will be found dead forms, with their internal structure unchanged, and others which are mere empty shells or skins. Some of these latter are, doubtless, 'cast skins,' but the dead water-bears, in a trough not very plentifully supplied with food, will soon be attacked by paramæcia; and although the aperture they make may not be clearly seen, they somehow get into the body of the animal and gradually devour all that is in it; and after cleaning it as thoroughly as ants will a small skeleton, leave it a hollow but perfect form. It is now open to the chapter of accidents, and it can be no matter for surprise that the minute eggs of aquatic creatures enter it and hatch there. This can be easily illustrated. Mr. G. F. Chantrell, the secretary of the Microscopical Society of Liverpool, is a very careful and constant observer of pond-life. He has endeavoured to verify or substantiate some of the more marked cases presented by Dr. Bastian. But his method of examination is, of necessity, an interrupted one. He has frequently called my attention to curious cases of apparent 'transmutation,' and I have before me now some of his drawings of these taken from nature. In Fig. 15 *b*, I reproduce one, which it will be seen is extremely like the one figured by Dr. Bastian

(Fig. 15 *a*), which, it must be remembered, he affirms, on the assurance of Gros, was full of germs by the resolution of its internal substance; and that each of the germs was 'capable of developing into a tardigrade.' But, fortunately, Mr. Chantrell did not leave the germs to their capabilities; he suspiciously followed them out, and they became stentor cæruleus! As drawn, after hatching, they are presented in the attached or fixed state at 15 *c*, and in the swimming condition at 15 *d*. Clearly, the eggs of the stentor had got into the dead hollow body of the tardigrade and developed there!

"That this inference is a correct one I have repeatedly verified, and at Fig. 15 *e* give an additional instance in proof. This is the hollow, perfectly transparent skin of a tardigrade. Nothing has been left within but the hard retractile tube and 'gizzard,' and these, as seen at a^1, have fallen from their true position. At b^1 a small oval body was seen perfectly, and watched, and eventually the small rotifer, c^1—probably *Monura dulcis*—emerged from it, and at length escaped from the skin of the Tardigrade altogether. Surely it is unsatisfactory science to consider a phœnomenon like this 'heterogenesis,' and to label it 'homogenetic pangenesis in tardigrades!'"

Now, since the publication of this paper, I have received evidence of many similar instances. In Fig. 16 *a*, I give one. I received from Devon some little time since a jar of water and vegetable matter from a bog. It was, as it was reported to be, plentifully peopled with tardigrades and the rotifer known as *Callidina elegans*. It was by no means difficult to find the cast or emptied "skins" of tardigrades. *a* is one of these which was found on the fourth day after the water and "weed" had been put into a "trough." It was seen first in the state figured. The eggs within the empty body are manifestly the eggs of the callidina; but this in the sequel was not a matter of mere conviction, but became

a demonstrated fact, when from one of the eggs the form seen in *b* emerged and mingled with its fellows. The other eggs never produced anything, probably having been injured. They simply decayed and broke up. Then it becomes manifest that Dr. Bastian's curious assumption of the heterogenesis of the tardigrade's body substance into eggs, because eggs appeared in and filled that "body," is refuted by Mr. Chantrell's observations, and the cause of the appearance of stentor, rotifer, and other eggs within the carapaces of tardigrades is explained by the observations of many.

But it is still more curious to find that such absolute refutations as have been given by experts in their own several departments of biological research, of the *assumed* instances of Heterogenesis, published in the *Beginnings of Life*, have not in all minds suggested the need, in observation, of the extremest caution. How serious the resulting errors are, in only one direction, has been shown plainly by Prof. H. L. Smith,* of America, whose competence to write critically on the subject of Diatomaceæ will not be disputed. He has given an absolutely destructive detailed criticism of every important instance of the reputed transmutation of something else into Diatoms which Dr. Bastian has presented, and brings out clearly the mistake of attempting to infer the "heterogenetic" origin of vital forms of whose ascertained history the observer was ignorant. Professor Smith says, "I have probably witnessed more of the phenomena ot conjugation and growth than any other person, and can affirm, without fear of being disproved, that . . . any kind of transformation of Pediastreæ or Desmids into Diatoms never has happened—nay more, never will happen." "I look," he continues, "more particularl to the evolution of Diatoms, fully convinced, however, that

* Archebiosis and Heterogenesis. *The Lens*, Jan., 1873, and *Quart. Journ. Micro. Science*, vol. xiii., p. 357, and note by Mr. Archer, *ibid.*

PLATE V.

Fig. 17

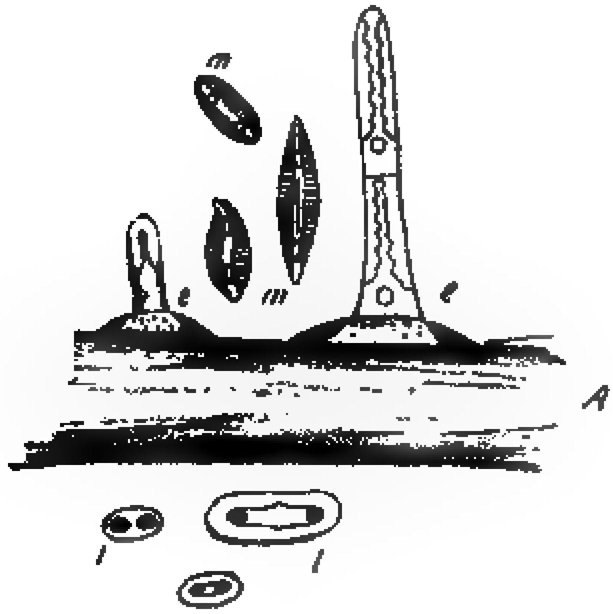


Fig. 18

the errors of misinterpreting what he (Dr. Bastian) saw are quite as great with the Desmids as with the Diatoms." For example, Fig. 17, Plate V., is a reproduction of one of Dr. Bastian's figures, which he declares represents, at *e e*, the "heterogenetic" origin of Diatoms from the Cladophora filament A. Professor Smith says, poor as the cut is, we easily recognise the "pedunculated diatoms" as "*Acanthes exilis* in its normal condition!" In fact, it constantly grows naturally thus on Cladophora, Vaucheria, and other algæ. But, because Dr. Bastian was not aware of this, he took the observation as a fine illustration—which in view of the facts we have no objection to admit—of Heterogenesis. Whereas, "if it had been allowed to live it would have continued the process of self-division, until finally . . . a new sporangium would have formed the commencement of a new series." Again, Dr. Bastian affirms the small forms figured at *l l* (Fig. 17), are algoid vesicles budded off from Vaucheria, and that they "gradually become converted into different kinds of diatoms." And further, "these bodies increased in size, and it soon became obvious that they were young Naviculæ (*l l*); the exact pattern assumed in the early stages is subject to much variation, and several different Diatoms seemed to be produced corresponding to these initial forms, *m m*." (Fig. 17.) "This," says Professor Smith, "would be wonderful if true; but not only is there no evidence that actual diatoms did come from the vesicles of Vaucheria, but any one familiar with the observation of living diatoms can tell where they did come from . . . They were in the gathering . . . and made their appearance out of the *débris* . . . as we know they will do under the influence of light . . . But, besides, diatoms do not grow by increase of size; there are no such things as broods of young frustules. . . . The late Dr. Greville . . . fully agreed with

me in this." Further, Fig. B, Plate V., is a copy of another illustration given in the *Beginnings of Life*. It is declared to represent the "resolution of Englena into diatoms." It is said concerning it that "the whole of the contents of an englena seemed to have been resolved into distinctly striated Naviculæ . . . Although the earlier stages of the transformation were not seen (!), I have no doubt that the diatoms originated in this way." Upon this Professor Smith observes: "He (Dr. Bastian) is more easily satisfied that an englena can transform into a diatom, which possesses a wonderful silicious and beautifully sculptured epiderm, than he is that bacteria come from air-germs," and then he clearly shows that the group of Naviculæ seen in Fig. B are simply a group that were devoured, and their protoplasm digested by an amœba. They constantly are ejected in this way from the body of the amœba after the nutrition has been abstracted, and look like an encysted mass with an envelope complete; and even when treated with acids, although the envelope disappears, the frustules still adhere. And Professor Smith has "slides, as well as materials, showing this in abundance." All this, it may be presumed, is capable of suggesting two things: 1. The danger of attempting to discover new modes of "genesis" until we have made ourselves acquainted with the old ones; and 2. That "Heterogenesis" is not even a scientific hypothesis, for the "facts" on which it is founded have not received scientific investigation.* But the caution suggested by all this is evidently not in every case a prophylactic; although it certainly has been so in the case of a great majority of working Biologists, whether amateur or professional. But we have few of us, probably, been called before to witness so remarkable an alleged evidence of the nature, persistence, and transmutable power of "Protoplasm" as was brought before us a

* "Heterogenesis." *Popular Science Review*, vol. xv., 346.

little while ago, in which we were called on to consider an illustration of the emergence of lowly living organisms from what was declared to be the transmuted "protoplasm of *sawdust!*" It was gravely asserted that *wood sawdust* contained protoplasm; and that this, which it had inherited from the tree of which it was a part, had the power heterogenetically to become —living organisms. The proof was that bacterial and monadic forms had been found in an infusion of which the sawdust was the essential ingredient! and it was supposed to be the more remarkable, from the fact that the sawdust had been prepared from wood which had constituted a pile of an old lake dwelling. It consequently had an antiquity, as *dead wood*, which might be greater than that of the historic antiquity of man in Europe, and, for aught we really can determine, greater than chronological antiquity of man upon the earth. Yet, although it is a piece torn from a dead tree of such a vast period since, it is supposed to contain—protoplasm—the life-stuff that gave the tree from which it was riven, its vital and physical characteristics—in its *living entirety?* and that this "protoplasm" had the power to change itself into separate and specialised living forms!

The grounds of this bizarre and incongruous "inference" are simply that living forms appeared in the sawdust infusion! which is no more and no less than every practical Biologist would expect. *Anything* that will *carry* "germs" or desiccated septic organisms into water that favours, renders possible, or indicates a putrefactive state, will rapidly give rise to putrefactive organisms. The "sawdust" from this lake dwelling pile had been saturated for thousands of years with the water of the lake. It doubtless contained germs of life in various forms. But unless it were, in the form of minute broken particles, introduced into a vessel in such a way as to have no contact with the outer air, and to be hermetically enclosed in sterilised water, it would be impossible to dis-

cover *even what these germs, contained in this saturated wood, were.* But when the wood is sawn into "sawdust," without precaution, and put into an ordinary "live-box" for study, what could we expect *but* living products? They *must* be there, as the experience of the practical Biologist has everywhere shown. Some of them would have been there equally if it had been bone-dust or stone-dust that had been there instead of sawdust. But to argue that such living things are the outcome of the "transmuted protoplasm" of the said "dust," is either to ignore, or be unacquainted with, all the elements which constitute our recent knowledge of minute life, and all the facts which have enabled recent science to formulate the magnificent generalisation which finds in protoplasm the physical basis of life.

I have in my possession some fragments of a wooden hutch which was used by me for many years as a shelter for offensive putrefactions, from which septic organisms of various kinds were derived for study. A month ago I sawed and filed some of this, and placed it with minute broken fragments of the same wood into a vessel with water, and a little of Cohn's nutritive fluid, which was kept at a temperature of 62° F. In Plate V., Fig. 18 *a*, I show the result of the examination of a minute drop of the surface film after four days, where the earlier forms of Bacteria are in vast abundance, and in the drop were intensely active.* At 2 the same fluid is seen more generally examined four days after, when *B. lineola, Bacillus ulna,* and even *Spirillum volutans* struggle with *B. termo,* and prevail; and a few early developments of monads appear. In the quadrants 3 and 4 the general result of examination on the twelfth and sixteenth day are manifest, and all these forms were the common forms upon which, at the time, this out-door cupboard was employed for the protection of the infusions on which

* Only a quadrant of the "field" in each case is shown.


6

Dr. Drysdale and myself were at work. It was simply evidence of what has been often given before, that the germs of the putrefactive organisms can persist in air undeveloped; but on entering a suitable fluid, are at once stimulated into development and increase. The wood of the cupboard was charged with germs. These were the germs of forms whose life-histories in many cases were known. They *succeeded* each other in time; they did not all appear together; but this, so far as we at present know, is dependent upon the condition of the fluid as superinduced by the forms that have gone before. Certain it is that their life-cycles are independent of each other. The monads are no more "transmutations" of the bacteria, than the graylings and trout of the Upper Thames are "transmutations" of its sticklebacks and minnows. It will complete the evidence which I have sought to give as to the need of caution in relation to hasty inference in the study of the minuter forms of life, if I take a case of its wise exercise from no older a source than the *Quarterly Journal of Microscopical Science* for April of this year (1880). It is furnished by Mr. Siddall in a paper "On Shepheardella, an undescribed type of Marine Rhizopoda."* It is a curious marine organism, seen in Fig. 1, Plate VI., which Mr. Siddall points out has a similarity of external form with the *Gregarina gigantea* of Van Beneden. But the observations made, although of great interest and value, were not, on account of fewness of specimens and, probably, want of knowledge of the life-conditions of the animal, competent to even indicate its life-history. Yet, to an observer in quest of support for a theory, there was much that was curious and "suggestive." In fact, the organism was simply seen in the main to break up into amœboid and actinophrys-like masses of protoplasm. Fig. 2 is a form of Fig. 1, in the first stage of "breaking up," where, indeed, in the course of time,

* Page 129, *et seq.*

changes had been superinduced in the normal organism. In one instance, in about five days, one in an apparently healthy state had passed from the normal condition (Fig. 1) into that seen in Fig. 3, which was a merely spherical shape with constrictions. In two and a half hours more it had again assumed the form shown in Fig. 2, and by the end of less than two days more it had broken into four parts, as in Fig. 4, which poured out anastomosing sarcode, as in Fig. 5, but this ultimately contracted into one principal mass; and from this, minute amœboid particles, and actinophrys-like bodies, as seen in Figs. 7, 8, which really were offshoots of the sarcode of the mass, as seen in Fig. 6.

Even this too-brief summary of the results obtained by these observations show how interesting they are, and lead to a desire for their early re-prosecution and completion. But in their present form, does their author endeavour to establish the doctrine of transformations by showing that Shepheardella becomes amœbæ and actinophrys? No; but he, as a careful naturalist, says, "From the foregoing account it will be gathered that little beyond the dissolution of *Shepheardella* into amœboid particles has yet been quite satisfactorily traced. No attempt at fission, encystation, or anything approaching to either, and no development of special reproductive bodies . . . has yet been observed. The loss of the specimen possessing three nuclei was a matter of much regret, as I had hoped, judging from what has been noticed in other simple organisms having more than one nucleus, that it might ultimately divide into three distinct individuals, and, by so doing, give conclusive evidence of at least one process of reproduction. As it at present stands, the life-history of Shepheardella may be looked upon as a chain, a *few links* of which are here presented, the major portion being still missing." *

* *Ibid.*, p. 137.

In conclusion, let it be remembered that the *facts of nature* are the only court of final appeal in science. Theories must always be either destroyed and cast away, or immortalised, by *facts* alone. Twenty years in the future will doubtless do for scientific knowledge in all directions what twenty years in the past have done—that is, modify much that is now rigidly held. But the broader the basis of fact on which a scientific generalisation is established, the less the probability of its being supplanted or even modified by succeeding facts. The scientific *mind* should, and would, find no difficulty in receiving Heterogenesis *if it represented a fact in nature*. But with the vast area of facts that absolutely oppose it, as definitely settled as the specific gravity of gold; and with the crude and undigested "evidence" brought by its advocates in its favour, we may scarcely anticipate that uncertainty or caprice in vital development, or a new power in "protoplasm" to disregard its *inherited tendencies*, will be amongst the *facts* that will make the light of human knowledge brighter in the years to come. In their obedience to law, every realm of nature is at one. But in the realm of life, the obedience is the most intense, because demonstrably subject to the highest and most wide-reaching of all laws—Evolution.

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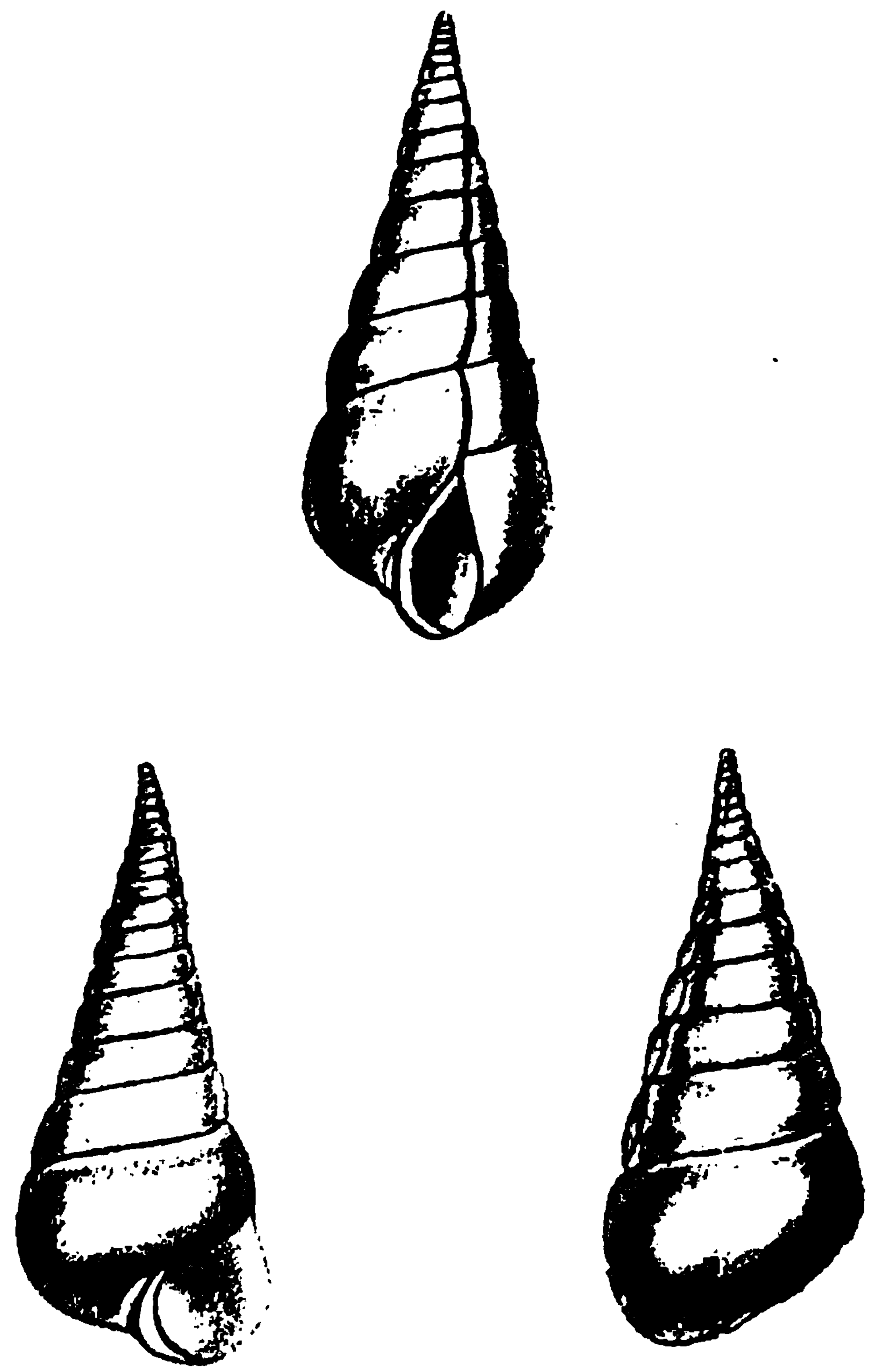


EULIMA CANDIDA, MARRAT.
(THE SHINING WHITE EULIMA)

CHARD, Delt.

EULIMA CANDIDA, MARRAT.

EUL: testa subulato-pyramidali, ventricosa, acuminata, solida, nitida, alba, apice flexuosa; anfractibus brevibus, convexiusculis, numerosis, planulatis; sutura impressa; varicibus impressis oblique continuis; apertura ovali, columella incrassata, antice reflexa, labro in medio producto. Long. 20, lat. 8 lin.

This is the largest shell in the genus Eulima, and appears to me to be distinct, but as I have only seen one specimen, I cannot say how far the distinctive character may prove to be permanent. Sowerby's Eul. grandis is only 6 lines broad.

The nearest shell, in both form and character, with which we can compare our specimen, is the Eulima Martinii, A. Ad., from which the shell before us differs in its larger size, rounder and shorter whorls, and in the varices not extending to the apex.

The specimen was obtained by Surgeon-major S. Archer, from a captain at Singapore. The locality is unknown.

F. P. MARRAT,

Scientific Staff, Free Public Museum, Liverpool.

JULY 4th, 1880.

ON THE

VARIETIES OF THE SHELLS

BELONGING TO THE

GENUS NASSA, LAM.

BY F. P. MARRAT.

INTRODUCTION.

THE study of varieties in the genus Nassa has achieved one great object,—it has taught us the whole details of the plan on which the external ornamentation of shells has been elaborated. The whole of the variation, from the smooth shell to the most distinctly sculptured examples, is plainly to be seen as effected through almost imperceptible gradations.

An attempt might be made to show the lines of divergence by means of a diagram, but in all the instances in which this has been done in other branches of Natural History the results have not been satisfactory.

Neither a tree-like form nor any genealogical chart could be made to represent varieties in anything like the ramifications in which they occur in Nature, nor could we hope to succeed in such an undertaking without being able to procure a very large additional series of species such as would enable us to follow more closely the missing links in the scale of affinity.

For the most part, I do not regard a peculiar character possessed only by a single specimen as constituting a "variety." Even "intermediate links" between allied forms are generally represented in my series by two, three, or more, closely similar specimens.

Variation through the whole kingdom of Nature is the rule and not the exception. It is the prejudice exhibited by Scientists, against so much that is clear and distinct, that creates confusion. If studied as it exists, the whole group is manifestly developed, step by step, and we see the wisdom, power and beneficence of the Maker. We see the qualities implanted in these creatures to enable them to construct their houses with consummate skill, and to ornament them, either plainly, in Quaker fashion, or most elaborately in external sculpture. Men are constantly inventing theories to account for changes occurring in Natural History objects, and everything must bend to suit their special hypotheses.

Only one arrangement can be correct, and we have only to examine the materials and gain an extensive knowledge of the sections in each division to be convinced of this truth.

The greater part of the works on Natural History are written in the closets of the authors, who both theorise and copy to a large extent; but, unfortunately, they copy errors as well as facts.

The study of variation has opened up a subject so vast in its dimensions that the mind almost shrinks from the task of estimating it. In every direction variation extends, in every way variation seems to ramify, until we gaze and wonder if there be any end.

Instead of 200 Species, at least 3,000 Varieties are before me, and the end appears nearly as far off as ever. Taking a careful survey of the shells under consideration, and noting more particularly the common forms and the changes presented by them, we are enabled to form an estimate of the enormous number likely to be met with, if we persevere in our work of collecting varieties.

Species are and have been made by men in their ignorance. Had they known the alliances, it would have been impossible for them to have committed such mistakes as are to be found in conchological books. Species have been and still are the ultimatum of scientists. It appears to me that they have an instinctive horror of the nameless. Lamarck described the Nassa subspinosa from shells that were subspinous, not then knowing that there were carinated, costated, muricated, and smooth

varieties of it. At least six good (?) species have emerged from the varieties of Lamarck's shell: N. lyrata, Marrat, is the lyrate form; N. tricarinata, Lam., is the carinated form; N. sculpta, Marrat, is another; N. sistroides, Neville, N. trinodosa, Smith, and N. corticata, A. Ad. Another variety occurs showing a close affinity with the N. muricata, Quoy and Gaim., and the shell figured in Reeve's *Conchologia Iconica* as the N. vibex, Say, is a spiny form. Some of the shells from Ceylon are very closely connected with varieties of the N. Gruneri, D'k'r., and others with smoother ribs to the N. Jacksoniana, Quoy and Gaim.

In the preface to *Wood's Catalogue of Shells*, published in the year 1828, we find the following remark: "It has, therefore, been the endeavour of the author, in the absence of larger and more costly publications, to supply their place by a work which will incorporate in one volume figures of all the known shells." From the statement here quoted the number of shells known to conchologists at this date amounted to about two thousand. A little more than fifty years have elapsed, and we find that the numbers have increased to at least thirty thousand. Suppose we recommend the study of a single genus to each of our conchological students; if the success attending their efforts be in proportion to those resulting from the study of the Nassæ, before this century expires we will have at least five hundred thousand shells. We may name these shells and describe them as distinct, but they will not be so after we have finished; on the contrary, we may adopt another plan and name them varieties, but the same objection continues; the variety we have named as coming from any locality will be found to differ from the shells brought up from the same ground by the next haul of the dredge. It is a very disagreeable task to be compelled to state that the starting point of the systematist, upon which the whole fabric is built up, is wrong, and the whole of the deductions drawn from this source are erroneous; nevertheless, I am compelled to utter that which I believe to be strictly and unquestionably true. I cannot expect the conchologists, who are totally unacquainted with the materials upon which I have based my deductions, will be found to coincide with my views. If they had studied the genus

Nassa and had obtained a knowledge of the whole of the species either figured or described in it, they could not by this plan follow the intricate passages revealed by the study of variation. It is not by the intimate knowledge of the species themselves that these facts are elicited, but it depends upon a knowledge of the innumerable intermediate forms which diverge from them in every direction as to how these deductions are to be drawn. The conchologist and I are dealing with two distinct subjects, intimately connected, but differing materially in the result obtained; the one is confined to the number of the shells figured and described, while the other wishes to embrace every variety occurring in creation, most of which are neither figured nor described.

When the whole series is spread out, in lines in their trays these shells forcibly remind us of the people standing round a race-course when the horses are running. The different sizes in height and breadth, the different coloured clothes, the marked differences in form and feature, and the various casts of countenance, all exhibit, in proportion to the difference in the size of the objects compared, just such an amount of variation as we find in the varieties of the Nassæ.

The lines of descent from the largest to the smallest forms are often distinctly indicated, notwithstanding the large number of variable shells intervening between the first form and the last.

Shells may be selected, in series, that will show a clear line in the descending order from Nassa glans, Linn., to Nassa incrassata, Müll., variety glaberrima; but if these varieties are examined in the order in which they appear to fall naturally, then we find that an off-shoot takes place at the junction of the varieties of Nassa mucronata, A. Adams; another with Nassa Marratii, Smith; a third with the Nassa gaudiosa, Hinds, etc. Another of these lines may be started with the Nassa trifasciata, Gmel.; but in this case, instead of tracing smooth shells, as we did in the last, the shells would pass into coronated, costated, and cancellated forms before returning to a similar small form to that with which we started. Most of the costated varieties such as Nassa nodifera, Powis, the cancellated varieties such as Nassa marginulata, Lam., and the elongated series

such as Nassa sequijorensis, A. Adams, would form a part, and a very important part, in this line of descent. One of the series of shells in which the most gradual and almost imperceptible grades of variation takes place is that commencing with the Nassa turrita, A. Adams, and ending with a shell very little larger than Rissoa costata, viz., the Nassa costulata, found fossil in the Miocene of Bordeaux. This series includes the Nassa limata, Chemnitz; prismatica, Brocchi; lucida, Marrat; proxima, striata, and versicolor, C. B. Adams; denticulata and rufocincta, A. Adams; crebristriata, Carpenter; annellifera, Reeve; ambigua, Montague, etc.

In a long series of forms, commencing with shells representing the largest specimens in the genus, these can be traced with unerring certainty into others forming the smallest examples known to exist; again, the broadest varieties can just as easily be connected with others that are the narrowest examples in the group; and every grade of difference throughout the long lines of progressive variation is distiuctly seen.

In a case of the shells having smooth forms, such as N. glans, Linn., the varieties may not be all smooth specimens, but they may vary into costate and even cancellated examples. Again, instead of there being a uniform rate of variation of thickness observable, one set will be almost transparent or thin and hyaline, and another thick and quite opaque. The sculpturing is in many cases confined to the upper whorls, but we find shells in which the pattern is commenced on the top gradually spreading in successive development until it covers the whole shell; in one case it may form smooth unsculptured ribs, or in another it may diverge into any of the forms of sculpture we meet with in other groups of shells. The tip of the spire may be of the same colour as the remaining portion of the shell, or it may vary into almost every shade of pink, rufous, brown, purple, or almost black.

The shells used as starting points are not intended as distinct forms, nor are they anything more than varieties chosen for the purpose of illustrating the subject of variation through a number of its ramifications. All the divisions marked with a dash will be found to assimilate with each other in some of the varieties

occurring in each section. The N. nodifera, Powis, is a costate variety, intermediate in its character between the smooth shells of N. trifasciata, Gmel., and the cancellated forms of N. marginulata, Lam., and similar remarks will apply to all the shells forming the starting points.

The arrangement of these shells is purely and simply as it exists in Nature, and only requires the student to examine it without paying any attention to the specific distinctions propounded in the works of the most learned conchological authors, to be convinced of its correctness—NASSA IS ONE SHELL IN AN ENDLESS VARIETY OF FORMS.

In my Paper on the "Variation of Sculpture," some of the modes in which these shells vary have been pointed out; others, still more complex, remain to be explained. Again, starting with the smooth forms, the first and possibly the most abundant variation is that in which delicate longitudinal lines appear all over the shell; at first they are irregular and interrupted, but at length they appear with tolerable regularity; then the cross-grooves make their appearance, beginning with a few and increasing in number until we have a finely cancellated shell; this is easily observed in varieties of N. planicostata, A. Ad., and N. labida, Reeve.

As the lines increase in size, and the cross-grooves in depth, the external pattern becomes larger, until it is of a very coarse kind,—this is only one of the simple forms; another, and one that is very common, is the different sizes of the ribs, traversed by cross-grooves, forming somewhat square spaces by their intersection,—these have rounded surfaces, derived from the rounding of the ribs (N. reticulata, Linn., is an instance). A curious instance of the square spaces formed by these intersecting lines being placed at nearly equal distances from each other is seen in specimens of the N. nodulosa, Marr. Smaller and more numerous squares may be seen on the N. cremata, Reeve (not Hinds!), N. ravida, A. Ad., etc. In other shells we find, not square spaces, but elongated ones passing into parallelograms of different sizes, and sometimes placed at slight angles to each other. Instances of this sculpture are found in the N. stigmaria, A. Ad., etc. The nodules are

sometimes most irregular, both in size and rotundity; an instance of this occurs most conspicuously in the N. nodosa, Marr.

The various changes that take place in the shelly matter deposited on the margin of the sutural canal is used by the conchologist as one of the characters for the discrimination of the different species; how far this can be relied upon as permanent may be inferred from the following remarks, commencing with the shells having the body-whorl gradually tapering into the penult without increasing in thickness at the sutures. Examples—N. rufula, Reeve, N. glans, Linn., varieties, N. Marratii, Smith, &c.; thickened, and forming a sharp callous edge to the sutural canal (suture canaliculate)—N. spirata, A. Ad., N. lævigata, Marr., var., and N. canaliculata, Lam., &c.; tumid—as in N. tænia, Gmel., vars., N. Glans, Linn., vars., and N. picta, D'k'r., vars.; the tumid band divided by groove-lines—N. glans, Linn., vars., N. coronata, Brug., and N. lævigata, Marr., vars.; with close and numerous folds—N. crispata, Marr.; beaded or coronated—N. cælata, A. Ad., var. N. variegata, A. Ad., and N. cremata, Hinds; strongly noduled — N. arcularia, Linn. Every grade of difference between two extremes in shells, in what are termed of the same species, may be traced thus: N. glans, Linn., presents examples of each of these changes in the series from one end to the other, and several other variable shells change in a similar way; and, as almost every shell has points of difference, and consequently varies, the shelly matter on the margin of the sutural canal becomes a doubtful character for specific distinction to be based upon.

The nodules near the sutures are either flattened like the ribs, or raised into large tubercles, such as we find on the N. arcularia, Linn., and all the intermediate sizes may be found in the different varieties. If the shell be finely cancellated, the beads will be small and numerous; but if the ribs be broad and the cancellation coarse, the beads will be large. The groove-lines forming the transverse sulci are situated at almost every space on the shell, from the base to the apex. The ribs may extend from the suture to the base without having a single groove-line, or they may be intersected at regular intervals; the line just below the suture in a shell before

me is so close that it appears to cut the beads into two parts, and another variety of a shell similar in almost every other respect, has the first groove-line in the centre of the body-whorl. When the ribs are interrupted at a distance from the suture, these short ribs are termed riblets, and they vary from being a little longer than broad, until they reach beyond the centre of the whorl. In a group of four specimens just examined, all the varieties with the exception of one are plainly ribbed, without being coronated, but the last has distinct beads; thus we have a change from one to the other in specimens which are apparently merely varieties. From these observations taken from the shells, and not intended to support or illustrate any theory, it is very easy to see that instead of a fixedness in the characters used for the determination of species, exactly the opposite appears to be the case; the specimens presenting such an amount of variation in every direction that it becomes absolutely impossible to affix any set of characters to them that will lead to their future recognition.

The sub-genus Aciculina, H. and A. Adams, is made up of varieties of one shell. The N. labiosa, J. Sowerby, in Wood's *Mollusca from the Crag*, is simply a grooved form of the Philippine shell, N. maculata, A. Adams, and Professor E. Forbes was quite correct in the statement of its being a variety of the N. propinqua, J. Sow., or semistriata, Brocchi; the comparatively smooth forms pass into varieties of the former, and the flattened ribbed varieties into the latter shell. I do not consider the suggestion of Mr. Bell as being either impossible or even improbable, when he states that varieties of N. propinqua closely resemble, and may be considered to be, varieties of N. trivittata, Say.

The nodules occur in three different ways, viz., as protuberances on the ribs, in the square spaces formed by the transverse and longitudinal lines, and at the junction where the lines cross each other. In the N. subspinosa, Lam., the tubercles are very prominent on the ribs, and some of the varieties have them produced to a point, hence the name; the cross-grooves are rather close and waved, but we find other varieties of this shell without the nodules, their place being occupied by strong raised ribs; others again have sharp

carinæ or keels running across the shell, and in shells very closely allied to them we find that the characters so prominent in the noduled shells have completely changed and become smooth. This is a change from one of the roughest examples of external character to the smooth unsculptured shell. Specimens that are intermediate in sculpture and possessing both forms, that is, the pustules or nodules on the ribs, and those with nodules at the junction of the intersecting lines, may be seen in the N. tritoniformis, Kien. The occupation of the squares by rounded papillæ occurs in the shells of N. gemmulata, Lam., from Ceylon, but the Philippine variety, as figured in Reeve at pl. 5, f. 29, is a ribbed shell, with intersecting cross-grooves, and every intermediate variety connecting the two are in a tray lying before me. The best examples of the third kind of pustules, viz., those occurring at each corner of the squares formed by the junction of the transverse and longitudinal lines, may be seen in the N. reticosa, A. Ad., N. Roissyi, Desh., N. cremata, Hinds, &c. N. candens of Hinds presents another modification of this last ornamentation; instead of the squares being distinct we have one, two, or even three transverse lines occurring between the principal ones, making the whole surface very irregular. A similar instance of intermediate transverse striæ occurs in the varieties of N. sordida, A. Ad., from Australia, and I think it is very probable that the large variety of N. Gruneri, D'k'r., viz., the N. echinata, A. Ad., is a tubercular variety of N. sordida. None of these shells have permanent characters, nor can they be of any value specifically, inasmuch as there is no depending upon them. In a tray before me are four shells of N. cremata, Reeve, all collected together, and to all appearance in form, colour, and marking they are similar; but the pocket glass shows at once that there are no two of them alike; one has the squares similar to the figure in Reeve, the next forms parallel ribs in which the parallelograms are very narrow and elongated, a third shows a tendency to become pustular. Another tray has three shells in it, and these, like the last, were all obtained at one station and, if I am rightly informed, they all came up at one haul of the dredge; the nearest figured shell to which they may be referred is the N. marginulata, Lam., Kein., pl. 29,

f. 117; the first has square spaces, the second is ribbed and transversely grooved, and in the third the ribs are drawn up into sharp edges. Another tray containing four specimens exactly intermediate between the N. cremata, Reeve, and the N. marginulata, Lam., present still greater differences, *inter se*: the first has squares on the upper part of the body-whorl, each being divided by a grooved line; then the sculpture changes and the centre of the whorl has rounded—almost pustular ribs, and at about one third of the length of the whorl from the base the knotted squares occur, so that the three principal forms of sculpture are here present on the one shell; in another specimen the ribs are distant and simply intersected by cross-grooves; the callous of the columella also differs in each of the specimens; in the first it is thick and spreading, in the next it is less so, in the third it is still less, and in the fourth it is almost confined to the edge of the columella. The shells of N. sequijorensis, A. Ad., are for the most part of a character intermediate between the shells with smooth ribs and the cancellated varieties; they are finely or coarsely ribbed, some of them are smooth in the interstices between the ribs, others have a few sulci, and again we have the sulci close and numerous; in some specimens the ribs are smooth, in others they are sparingly cross-grooved, and lastly they are closely cancellated. Neither colour nor texture appear to be of any use in attempting to decipher the shells in the group to which N. sequijorensis, A. Ad., belongs; some of its varieties are white with pale rufous bands, and intermediate forms connect these with shells that are as nearly black as it is possible for shells to become. The texture is sometimes almost hyaline and the shells are thin, and these are connected by intermediate forms with others that are thick and heavy. The sutural canal in one specimen is closed or only represented by a fine line, but the specimens gradually change until it becomes rather widely expanded; the prickly serratures on the lip vary from the smallest and most simple rudimentary forms to the fullest state of development.

The greater part of the shells figured and described as new species have for their recommendation to our notice a single specimen, and that often in bad condition. Men are so anxious to have

their names appended to something new that every other consideration is overlooked by them. They cannot wait until sufficient evidence be produced either to confirm their opinions or show them that the characters they had given were incorrect, but down it goes on to paper, and there it remains. It will not be very difficult to decipher what amount of time and trouble is expended over these christenings when we see such a shell as the N. fossata, Gould, one of the largest shells in this genus, and about which there has been more discussion than any other, re-named in 1868, N. Moreleti, Crosse, ten years after it had been raised from a species to a sub-genus by H. and A. Ad., under the title of Zaphon elegans, Reeve.

In my list of affinities occurring amongst about twelve hundred varieties, the examples have been selected for the purpose of showing special peculiarities connecting shells said to form distinct *species*. All the more closely filling-in forms occurring between them have not been noticed.

The common shells, such as the Nassa reticulata, Linn., incrassata, Müll., with its variety glaberrima, Gmel., &c., appear to radiate into the shells of every other group, like a star composed of many rays.

We find these shells varying in form in every direction; one shell will be tall and elongated, and the next lying beside it will be short and dumpy; the body-whorl will be much longer than the spire, while its companion will have the spire longer than the body-whorl. One will be a giant, and another a pygmy; and intermediate forms occurring between these extreme varieties will so connect the whole that it would be impossible to separate them without doing violence to observed facts.

I have five specimens of N. compta, A. Ad., all so named by men well known in the conchological world, and yet they are all different; this being so, fixity of species seems to be relegated to transcendental conchology.

The N. tænia, Gmel., passes into the N. canaliculata, Lam., the N. lens, Chem., the N. nitidula, Linn., and the N. trifasciata, Gmel.; and the partially ribbed shells are intermediate between it and N. nodifera, Powis, into which it merges, and the small cancellated

varieties from New Guinea connect it with the N. marginulata, Reeve, and the N. margaritifera, D'k'r.; the two shells figured in Kiener, at pl. 14, f. 49, as varieties of N. crenulata, Lam., and Smith, P. Z. S., 1879, as N. sequijorensis, A. Ad., var., p. 181, pl. 20, f. 45, from Japan, are intermediate forms connecting the smooth with the cancellated shells.

The shell named and described in Philippi's *Abbildungen* under the title of Nassa albescens may be a variety of at least six others. These albinos are by no means uncommon. A shell before me is a white variety, with a purple apex, of the N. sordida, A. Ad., from Borneo; a second slightly banded is from the Philippines; another is nearly allied to the N. hispida, A. Ad.; a third is a white variety, with a dark tip, of the granular form of the N. nodicinta, A. Ad.; a fourth resembles the shell figured in Reeve's *Conchologia Iconica* as the N. Isabellei, D'Orb, but is white; a fifth was sent me by a gentleman who gathered it on the shores of the Red Sea—it is white with a rufous apex; and lastly, Reeve has figured another shell at pl. 15, f. 100, as the N. albescens, Phil. What the N. bicolor, Hombr. and Jaq., is, I do not know; but it is quoted as a synonyme of Philippi's shell. Some of my white shells are without a coloured apex. A variety with square, flat spaces covering the shell, is in one of my trays. Varieties of other shells are often coloured at the apex; N. picta, rufula, mucronata, etc., are examples, and several of these albinos have faint coloured transverse bands. I have two white varieties of the N. splendidula, D'k'r.

In the case of N. lentiginosa, A. Ad., following the line from the broad to the narrow shells, we find the varieties passing through the narrow forms of the N. velata, Gould, into the N. polita and insculpta, Marr., this latter shell being so like a Terebra that the late H. Adams had to be consulted to decide the question with regard to which genus (Nassa or Terebra) it should be referred.

Nassa micans, A. Ad., Reeve, pl. 21, f. 140, is the smooth form of the N. planicostata, A. Ad. At plate 12, f. 76, is figured a variety of the last-named shell, with only very close faint lines upon it, and the second figure, pl. 14, f. 94, represents it in its costate and sulcate forms. Another and somewhat shorter and

broader variety is before me; it is also smooth like the first-named shell, and we have a corresponding variation of form in the variety N. foveolata, D'k'r., Martini and Chemnitz, 2nd. ed., pl. 6, f. 1, 2, 3, having an intermediate form in the shell figured by Reeve at pl. 13, f. 83. While some of the shells are broader than many of their more favoured figured brethren, others are much more elongated and narrower. A close alliance exists between the varieties of these shells and the varieties of the N. succincta, A. Ad., both as regards form, colour, and sculpture. The N. exilis, Powis, may be only a stronger ribbed variety. Some of the narrow shells belonging to the N. marginulata, Lam., and N. sequijorensis, A. Ad., completely amalgamate with them, and the N. corniculum, Olivi, has many points of resemblance with them. In the N. crispata, Marr., the whole surface is covered with crisp longitudinal and transverse lines, being closely covered with granules in one variety, showing the knotted structure in a second, and a third shows a curious series of concentric rings, closely studded with elongated semi-tubercular longitudinal short ribs.

I could make any number of good species, and, as Lamarck often exclaims, they shall be *jolie et tres distincte*, but I must then carefully avoid letting my collection be seen by any conchologist afterwards, more particularly by one who has a critical eye in his head, because he would detect the fraud. A case in point has just occurred to me. Examining some shells of N. picta, D'k'r., figured and described by conchologists as having a smooth columella, I found that some of them have the columella strongly plicate. Here, then, is a character that would serve to distinguish it, so that a child could detect it; but unfortunately, the comparison instituted between the smooth and the plicate varieties revealed all the intermediate stages between the one and the other. Suppose these two extremes had accidentally fallen into the hands of a species maker, this apparent distinction would satisfy any number of his followers as far as relates to the distinguishing marks of the two species.

These observations regarding the sculpture are a continuation of those enumerated in my former paper on the Variation of Sculpture. They differ more in the detail than in any other respect, and

all further remarks could only be directed towards the elucidation of elaborate structure, having a tendency to corroborate the broad facts laid down, and more fully to illustrate the minor particulars in many of the changes observed.

Some of the abnormal specimens of Nassa nodifera, Powis, have the ribs most irregular in width, and apparently without any kind of order with regard to their arrangement. Instead of starting with a narrow rib and proceeding in a regular line to the broadest, or *vice versa*, the narrowest frequently occurs either beside the broadest or between two broad ones. These different breadths of rib in the same shell may be accounted for in the following way, viz., by the uniting of two or more of the tubercles at the sutures, and in confirmation of this we have the partial union of two in one case and three in another in a specimen of N. lævigata, Marr., on which the ribs have just commenced forming, and have not obliterated the grooves between the approximate tubercles. Another departure from the ordinary rule of a single rib to a single tubercle occurs, and that rather frequently, in specimens of Nassa arcularia, Linn. It is the uniting of two or three ribs in a single tubercle, rendering the direction of the united ribs almost like the radii of a circle. This is variation in a directly opposite way to that of the former case, both of which occur among the abnormal forms.

The nucleolar whorls forming the last volutions of the spire are said to afford good specific characters; but a careful comparison with both hand-glass and microscope has failed to produce any satisfactory results with regard to their constancy. These characters only appear distinct when we deal with distinct and selected varieties; but when the intermediate forms come to be examined in detail the characters are no longer satisfactory.

The evidence brought forward in the following pages is not intended to be in a consecutive form, but shows more particularly the extraordinary amount of variation to be found in individual shells, and how they pass by almost imperceptible degrees from one to the other. We are aware of the utter impossibility of accomplishing the task of uniting the whole of the shells collected as varieties and showing the exact progress each line has made

toward the completion of the whole from the largest to the smallest forms. If we could visit the whole of the stations on the face of the earth and could by any means obtain a view of the animals feeding at the bottom of the seas and rivers, and could obtain specimens of every variety of the shells, we might be able to so place them that the whole of the progressive development would be seen to be perfect from beginning to end. Starting with a certain hypothesis and working in every direction, the more the independent facts tend to agree, without being strained to suit the theory, the greater will be the probability of the hypothesis being right. Commenting on the specimens we have been enabled to collect, and placing them in the order in which they seem to fall, we have long lines of varying shells passing in their descending order from the large to the very small; we have other lines interrupted in various parts of the series indicating that certain forms would fill the gaps and render the whole of that section perfect. These forms may or may not exist, and we are compelled to seek in other divisions of the series for analogous examples. Applying the facts, easily to be observed in the series of shells of *common* occurrence, to the gaps that are open in *rarer* lines of descent, we are enabled to judge pretty accurately of the whole plan laid down, and in this way advance much nearer to the ultimatum than might have been expected. The constant changes in the direction of the lines diverging from the main stems produce the effect on the imagination that the whole series are more or less connecting lines between the great descending branches.

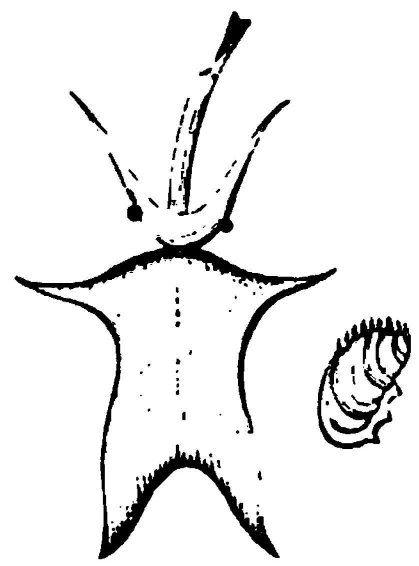
Whatever may be the result of future investigation with regard to variation, it must be borne in mind that the good figures and descriptions furnished by the conchologists who have gone before us have been the principal sources from which we have had to obtain our information. In the future it is more than probable that the photographer will furnish us with such accurate representations of the shells as will render the study of them comparatively easy. We may then be able to have a front and back view of each variety, more particularly of those taken in a single locality and at one haul of the dredge.

I do not wish to find fault with the men who described and figured shells; it is the determined pertinacity with which the species-maker adheres to and insists upon the characters being permanent with which I disagree. Naturalists in the early days of Conchology had few if any opportunities of judging how far the system of making shells distinct might be correct; in fact it is only within the last few years that we have been enabled to obtain the necessary materials for comparison.

With specimens most of which were rare and consequently high in price, even the rich were content with obtaining one or two examples of each. Of late years the influx of shells has produced the desired effect of rendering them easily procurable and at moderate prices, so that a few more or less is not now considered to be of much importance to the purchaser. The study of any particular division of this subject may be carried on for years by persons of moderate means, and materials may now be obtained to prosecute any line of investigation with comparative certainty of being able to pursue it with success.

The more extensive the subject of Natural History becomes the greater will be the necessity for men to confine their studies to separate branches of the science. By limiting our study to a single generic or even sub-generic division we can find ample means to examine the subject in all its details. Scientific men are and have been turning their attention more to the extension of knowledge in the form in which it is here carried out than in trying to grasp at more than the understanding is capable of retaining. Any of the divisions of the smaller Trochi, such as Euchelus, Ziziphinus, Trochocochlea, Omphalius, or that charming little group of shells Clanculus, might be examined with a certainty of obtaining very satisfactory conclusions.

The Mitres present characters very similar to those in the genus Nassa, and might be studied with every probability of interesting results.



Animal and Operculum of Nassa arcularia, Linn.

ANIMAL OF NASSA.

Head rather broad, often lunate, with pointed corners; eyes placed on stalks, either at the base or at various distances up to one-third from the tips of the tentacles. "In the Nassa reticulata, Linn., the mouth is a vertical fissure under the head, from which a very long proboscis is protruded, the structure of which is in all respects similar to that of Buccinum undatum, Linn., as are all the cerebral ganglia, the salivary glands, the double branchial plumes, the mucus fillets and the heart and auricle; all these organs I have dissected and compared with the same parts of that species, without finding any essential differences."—*Clark.* "Bullia rhodostoma, Gray, and B. achatina, Lam. Teeth of the radula, Eberhard, l. c. p. 14, pl. 5, f. 94, 95. Both agree well with Loven's figure for Bullia annulata, Lam., and show that this genus resembles Nassæ in the middle tooth being multidenticulated, and the true northern Buccinums in the denticulation of the lateral teeth."—*Zool. Record*, 1866, p. 179. The lingual ribbon is long and narrow, of crystalline transparency; it is often mounted as an object for the microscope. "Proboscis long, retractile, with corneous jaws, and a tongue armed with triple rows of teeth, of which the axile one is broad and sub-lunate, with numerous serratures, the laterals large and hamate."—

F. & H. Foot broad, expanded, and angulated in front; behind, acute as in N. tænia, Gmel., Q. & G., "Voy. de l'Astrolabe," pl. 32, f. 13; blunt, as in N. Isabellei, D'Orb., "Voy. dans l'Amerique," pl. 61, f. 19; slightly notched as in N. incrassata, Müll.; deeply nicked as in N. mutabilis, Linn.; bifurcate (each lobe divided into two) as in N. marginulata, Lam., var., "Voy. la Bonite," pl. 41., f. 1; and lobes distant as in N. arcularia, Linn.; caudal filaments varying in length; branchial plumes two; animal of various colours, blotched, lined, and dotted with lighter and darker tints.

The Nassæ are very active, and not at all shy when kept in confinement. They may be seen occasionally floating with the foot upwards; they feed on bivalves, the shells of which may be seen bored with circular holes; the shells of the Nassæ themselves are often seen similarly perforated. "N. reticulata is destructive to oysters, the shells of which are pierced by it."—*Zool. Record.* If the small round holes found bored in bivalve shells are to be attributed to the ravages of these and kindred mollusks, very few genera escape their attacks, and I have seen shells from West Africa, Ceylon, Singapore, and the Philippines so pierced that almost every second mollusk must have been preyed upon. A curious instance of want of judgment on the part of one of the Mollusca is before me—a solid spine of an echinus has been partially bored. Two holes are sometimes bored in one shell, the enclosed animal having been able to elude the grasp by retiring out of reach of the first attempt; how it fared on the second trial I cannot say.

The spawn cases differ in the different varieties; in N. reticulata, Linn., they are deposited on different substances, and are arranged in closely imbricated rows, being small compressed pouches. "In N. incrassata, Müll., they are solitary, yellowish, and shaped like a round flask with a small neck or opening at the top."—*Jeff.* They are found ranging from the littoral zone to 620 fathoms, the N. brychia, Watson, "Challenger" Expedition, having been obtained at this great depth. Some of the species have been observed to spring up and throw themselves over on being suddenly disturbed; they glide along the surface of the mud, leaving a

track indicating their line of march, at the end of which is a small round pellet; under this the creature conceals itself. The fry twist and twirl about by means of their ciliated lobes. N. mutabilis is used in Italy as an article of food and supplies the place of our periwinkle in the markets.

REFERENCES TO ANIMALS OF NASSA.

Voy. de l'Astrolabe.

N. tænia, Gmel. Quoy and Gaim., pl. 32, f. 13. Operculum, f. 15. Eyes situated at about $\frac{1}{4}$ the length of the tentacles from the base; foot large, expanded, tapering to a point at its posterior extremity (not bifid), with two caudal filaments.

N. coronata, Brug., pl. 32, f. 8. Operculum, f. 10. Eyes near the base of the tentacles; foot expanded, bifid at its posterior extremity, a filament on each side of the serrated operculum.

N. arcularia, Linn., pl. 32, f. 1. Operculum, f. 4. Eyes situated about $\frac{1}{4}$ the length of the tentacles from the base; foot bifid; caudal filaments not present in the figure.

N. margaritifera, D'k'r., pl. 32, f. 16. Eyes $\frac{1}{4}$ of the length of the tentacles from the base; foot bifid; operculum serrated.

A second description; foot quadrate below, broader in front than behind, colour milk-white, sub-pellucid behind, bifid, forming an angle of about 45° at the end; siphon short, truncate, cylindrical and grooved, bluish; eyes on a broad expansion of the tentacles.

N. bullata, Marr., pl. 32, f. 5. Eyes near the base of the tentacles; foot bifid; operculum crenated.

N. fasciata, Lam., pl. 32, f. 18. Operculum, f. 21. Eyes near the base of the tentacles; foot strongly bifid; operculum semi-ovate, serrated.

N. thersites, Brug., pl. 32, f. 22. Eyes at about $\frac{1}{3}$ of the length of the tentacles from the base; foot bifid; operculum ovate, nearly plain (abnormal), serrated at the base (normal).

N. pulla, Linn., globosa, Quoy and Gaim., pl. 32, f. 25. Operculum, f. 27 (abnormal). Eyes at the base of the tentacles; foot bifid; operculum sharply serrated, sub-trigonal.

Voy. la Bonite

N. nodifera, Powis, pl. 41, f. 2 Eyes near the middle of the tentacles; foot bifid; operculum serrated.

N. luteostoma, Brod. and Sow., pl. 41, f. 5. Eyes near the base of tentacles; foot bifid; operculum serrated.

N. gemmulata, Lam., pl. 41, f. 11. Eyes near the middle of the tentacles; foot bifid; operculum serrated.

N. nitidula, Linn., pl. 41, f. 14. Eyes above the middle of the tentacles; foot bifid; operculum crenated.

N. marginulata, Lam., pl. 41, f. 1. Eyes $\frac{1}{3}$ from the base of the tentacles; foot bifid; operculum serrated.

N. picta, D'k'r. Eyes near the base of the tentacles; foot bifid; operculum deeply serrated. From a specimen sent by S. Archer, Surgeon-major, Singapore.

Voy. dans l'Amerique.

N. dentifera, Powis. D'Orb., pl. 61, f. 22. Eyes near the base of the tentacles; foot plain, not bifid; operculum plain.

N. Isabellei, D'Orb., pl. 61, f. 18, 19. Eyes below the line of the head at the base of the tentacles; foot plain, not bifid; operculum plain.

N. riparia, Del Chiaje's Sicily, vol. 3, pl. 47, f. 6. Eyes near the base of the tentacles; foot slightly notched; operculum plain.

N. mutabilis, Linn., Del Chiaje's Sicily, vol 3, pl. 47, f. 6. Eyes at the base of the tentacles; foot bifid; operculum serrated.

N. læve, H. and A. Ad. (not Chemnitz), Rec. Moll., pl. 21, f. 7. Eyes near the base of the tentacles; foot bifid, deeply cut; operculum serrated.

N. reticulata, Linn. F. and H., pl. LL., f. 3. Eyes near the base of the tentacles; foot bifid, lobes acute. Var. nitida, Jeff., Brit. Conch., vol. 4, p. 349. Eyes in the centre of the tentacles. "Among a number of specimens which I dredged in the Roach River, one had two eyes in the right hand tentacle; the eyes were smaller than usual, and close together."—*Jeff.*

N. incrassata, Müll. F. and H., pl. LL., f. 1. Eyes near the base of the tentacles; foot slightly notched. Var. glaberrima, Gmel., Del Chiaje's Moll. Sic., pl. 48, f. 5. Eyes as in the last; foot bifid, lobes acute. Var. varicosa, Turt., F. and H., pl. LL., f. 2. Eyes as in the two last; foot bifid, lobes acute.

N. corniculum, Olivi. Zool. Adriat., p. 144. Eyes about $\frac{1}{3}$ from the base of the tentacles; foot bifid, lobes acute; operculum serrated. Another specimen had the eyes near the base of the tentacles; foot plain; operculum crenated.

DISTRIBUTION.

From Greenland to the Equator these mollusca roam every sea, and scarcely any attempt at deep-sea dredging has been carried on in the seas of Europe, Asia, Africa, or America without shells of this genus having been hauled up; they are most plentiful within the tropics, where the greatest number of varieties also exist. One of the largest forms—viz., the Nassa fossata, Gould—occurs in California. The Mediterranean varieties are both curious and interesting, presenting such an extraordinary diversity of sculpturing that inexperienced conchologists have exercised their talents and ingenuity in describing shells as distinct that appeared to all reasonable men to be only varieties of common and well-known forms.

OPERCULUM OF NASSA.

Serrated.

gemmulata, Lam.
coronata, Brug.
Kieneri, Anton.
mutabilis, Linn.
luteostoma, Brod. and Sow.
reticulata, Linn.
pulla, Linn.? globosa, Quoy. triangular.
gibbosula, L., and var. circumcincta, A. Ad.
tiarula, Kien.
Jacksoniana, Quoy.
antillarum, Phil.
thersites: some are serrated, others crenated, and others again are plain. Quoy and G., pl. 32, f. 34.

picta, D'k'r.
mucronata, A. Ad.
Webbei, Petit.
varicifera, A. Ad.
splendidula, D'k'r., or strongly crenated.
fraudulenta, Marr.
arcularia, Linn.
fasciata, Lam.
albescens, D'k'r.
Gruneri, D'k'r., var. hispida, A. Ad.
margaritifera, Reeve (not D'k'r.)
Woodwardii of Authors, Forbes (?).
neritea, Linn.

mangelioides, Reeve.
delicata, A. Ad.
semigranosa, Dkr.
labecula, A. Ad.
complanata, Powis.
livescens, Phil.
Gayi, Kien.
crebristriata, Carp.
crenolirata, A. Ad.
bimaculosa, A. Ad., and var. immersa, Carp.
picta, with a red brown centre.
sesarma, Marr.
argentea, Marr.

Crenated.

thersites, Brug.

bimaculosa, A. Ad.

lævigata, Marr.

glabella, Sow.

papillosa, Linn.
(I have only seen one).

glans, Linn.

suturalis, Lam.

cærulea, Marr., almost plain in some of the specimens.

luctuosa, A. Ad., drab, with a red stripe in the centre.

sculpta, Marr.

mitralis, A. Ad.
(only slightly).

obsoleta, Say.

Roissyi, Kien.

sparta, Marr.

Smithii, Marr.

incrassata, Müll., is plain, crenated or serrated.

Plain.

tænia, Gmel.

exilis, Powis.

plicosa, D'k'r.

trifasciata, Gmel.

sequijorensis, A. Ad.

monile, Kien. This operculum was crenated when fresh, and has become plain by drying.

margaritifera, Dkr., or very slightly crenated.

luteola, Marr.

dentifera, Powis.

lyrata, Marr.
or slightly crenated.

semistriata, Brocchi, or slightly crenated.

punctata, A. Ad., with a broad red-brown band across the centre.

VARIETIES OF NASSA.

1 Glans, Linn. Smooth at the sutures. Reeve, pl. 1, f. 5. Cuming, Philippines.

2 Slightly coronated at the sutures.

3 Similar in form, colour and marking to the two previous shells, but irregularly tubercled at the sutures. N. intermedia, D'k'r.

4 Body-whorl broader, paler, tubercles not much raised.

5 Similar to the last, but much deeper canaliculate, nodules strong.

6 Pure white, marbled with pale brown, apex purple, upper whorls costate, slightly tubercled.

7 Translucent, passing into white varieties of N. rufula, Reeve, pl. 2, f. 14. (? Kien.)

8 Reeve, pl. 2, f. 11. Port Jackson.

9 Whorls less rounded, not coronated, apex dark purple.

10 Narrow and elongated. Sandwich Islands.

11 Spotted with white and brown at the sutures, showing an approach to the N. mutabilis, Linn. S. Archer, Surgeon Major, Singapore.

12 Whorls flattened, sutures spotted, flamed with reddish brown, very similar in every respect to the elongated forms of N. mutabilis, Linn.

13 Very closely related to the N. elegans, Kien., pl. 24, f. 97. (Not Reeve!)

14 Broad and short, passing into N. rufula, Reeve, and N. spirata, A. Ad.

15 Dark brownish yellow, upper whorls cancellated, coronated, passing into the N. hirta, Kien.

16 Similar to the last, but strongly costate. N. suturalis, Lam. (variety of glans of all the old authors.) Mauritius.

17 Strongly costate and coronated. Australia.

18 With shorter, broader and rounder whorls, ribbed, resembling N. marginulata, Lam., in form.

19 Similar in form, but much thicker, resembling N. hirta, Kien., on the one hand, and N. lævigata, Marr., on the other.

20 Spirata, A. Ad. Reeve, pl. 2, f. 13. Swan River.

21 Similar in both form and colour to the Eburna spirata. Borneo.

22 More elongated, passing into N. mucronata, A. Ad.

23 Banded with reddish-brown lines.

24 With the whorls more regular than the last.

25 Sufflata, Gould. Hong Kong Harbour.

26 Mucronata, A. Ad. Reeve, pl. 2, f. 8.

27 Mucronata, A. Ad. Throat deep purple, tip sharply and regularly plicate.

28 Between N. mucronata and N. picta.

29 Between N. picta, D'k'r., and N. rufula, Reeve (not Kiener!).

30 Coronated at the sutures, two-banded.

31 Between N. Kieneri, Anton, and N. picta, D'k'r.

32 Filosa, Gray. Reeve, pl. 6, f. 35.

33 More oblique; is the N. obliquata, A. Ad. P.Z.S., 1851, p. 105. Philippines.

34 Elongated, apex pink.

35 Very elongated, coronated at the sutures, like the N. graphitera, Beck, blotched and spotted with dark brown.

36 Elongated, semicostate; N. gaudiosa, Hinds. Reeve, pl. 8, f. 48.

37 Intermediate between N. gaudiosa, Hinds and N. graphitera, Beck. Howland's Islands.

38 Lilacina, Gould.

39 Between the elongated varieties of N. glans, Linn., and N. graphitera, Beck.

40 Marratii, Smith. Jour. Linn. Soc., vol. 12, p. 453, pl. 30, f. 4. San Christoval.

41 Pale buff, thick, plain. Howland's Islands.

42 Gaudiosa, Hinds. Japan.

43 Paler, more elongated, and semicostate. Sandwich Islands.

44 Reeve, pl. 13, f. 85. Is more turreted, ribs longer.

45 Prompta, Marr. (See description.)

46 Shell elongated, costate, passing into the læta, Phil. Zeit. f. Malak, 1848, p. 144.

47 Polita, Marr. (See description.) Taylor Collection. Mauritius.

48 White with longitudinal orange lines, flamed and blotched with pale brown.

49 Spotted, sutures crudely crenated. Taylor Collection. Philippines.

50 Compta, A. Ad. P.Z.S., 1851. Reeve, pl. 16, f. 106.
Cape St. Antonia, Africa.

51 Purple; the colour is probably produced by acid.
Taylor Collection.

52 Elongated, a form of N. mucronata, A. Ad., passing into the narrow forms of N. glans, Linn.

53 Somewhat pellucid, white, with a few scattered reddish spots, the upper whorls costate, the ribs continuing on to the last whorl.

54 Dull grey, apex mucronate, semicostate, lined transversely, interior pale blue.

55 Reeveana, D'k'r. Phil. Abbild., pl. 2, f. 3. This is not the N. sertula, A. Ad., but a form of the N. picta, Dunker.

56 Picta, D'k'r., with dark brown and white interspersed over the shell; it is closely allied to the N. gaudiosa, Hinds, but is broader than the figure in the "Voy. Sulph."

57 With two brown bands on the last whorl.

58 Sertula, A. Ad. P.Z.S., 1851, p. 107. Reeve, pl. 14, f. 89.
Philippines.

59 Intermediate between N. sertula, A. Ad., concinna, Powis, and concentrica, Marr.

60 Concinna, Powis. Reeve, pl. 14, f. 91.

61 Mustelina, Gould. Pro. Bost. Soc. Nat. Hist., vol. 7, 1860.
Ousima.

62 Zonalis, A. Ad. Reeve, pl. 14, f. 93.

63 Rather strongly semicostate, passing into the following shell.

64 Capensis, D'k'r. Zeit. f. Malak, 1846. Krauss' Die Sudaf. Moll., 1848 = pulchella, A. Ad. P.Z.S., 1851. Reeve, pl. 14, f. 90. Port Elizabeth.

65 Beautifully mottled. Ditto.

66 Similar in colour and form, but longitudinally ribbed, strongly transversely grooved. Port Elizabeth.

67 With a dark brown central band.

68 White.

69 More elongated and narrow, intermediate between N. capensis and N. teretiuscula, A. Ad.

70 Aperture shorter, last whorl a little more expanded than the N. teretiuscula, A. Ad.

71 Beaded at the sutures; another variety of N. teretiuscula, A. Ad.

72 Dark bluish ash, costate throughout, showing an affinity with the N. exilis, Powis.

73 Scalarina, Marr. Pamphlet, pl. 1, f. 27. New Zealand.

74 With the last whorl semicostate.

75 Vittata, A. Ad. P.Z.S., 1851, p. 114. Reeve, pl. 24, f. 160. An elongated N. teretiuscula, A. Ad.

76 Ribs smooth, interstices closely grooved, N. serotina, A. Ad. Australia.

77 With smooth interstices.

78 Wax yellow, longitudinally ribbed and transversely grooved, N. tenella, Reeve, pl. 16, f. 163. Cases Bay.

79 Smaller, resembling varieties of N. incrassata, Müll., into which it merges; allied to the N. serotina, A. Ad. Reeve, pl. 16, f. 107.

80 Very narrow, white, and closely cancellated; is the N. rissoides, Marr. Pamphlet, pl. 1, f. 25.

81 Exilis, Powis. P.Z.S., 1835, p. 95.

82 Between N. exilis, Powis, and Stimpsoniana, C. B. Ad.

83 Glabrata, A. Ad. P.Z.S., 1851, p. 114. Reeve, pl. 24, f, 157.

84 Much narrower than the last, with darker and more numerous bands. N. glabella is the smooth form, N. maculata is grooved, N. labiata is the costate form, and N. vittata connects them with N. capensis; N. glaberrima, Gmel., and N. incrassata, Müll., are very closely connected.

85 Glaberrima, Gmel. Martini, pl. 125, f. 1177. Wood's Index, pl. 23, f. 90. Mediterranean, Eastern Seas, &c.

86 Freckled with brown and white dots.

87 Unifasciata, Kien., pl. 14, f. 50, is smooth, with a central brown band.

88 Taller and narrower than the last.

89 Cuvierii, Payr. Corsica, pl. 8, f. 17, 18; is beautifully mottled.

90 Very dark brown, columella expanded, resembling the shell figured by Kiener, pl. 20, f. 76.

91 Like unifasciata, band broader, and tessellated with brown and white.

92 Dark brown, very like the shell figured by Kiener as N. polygonata, pl. 27, f. 107.

93 Closely allied to the last is another shell, figured by Kiener at pl. 20, f. 76, as the N. Cuvierii, Payr.

94 With short interrupted brown transverse lines, varix strong.

95 Has transverse continuous lines, and is broader. N. tinei, Marav.

96 Greyish brown, tessellated below the sutures with brown and white. Kiener, pl. 20, f. 75.

97 Plain at the sutures.

98 Smooth, costate, with a brown central band. Reeve, pl. 19, f. 129.

99 Of a pale cream colour, with interrupted brown bands, ribbed and transversely grooved, broad.

100 Narrower, paler, tessellated at the sutures. Reeve, pl. 20, f. 134.

101 Yellow, lined and tessellated with brown. A very beautiful shell.

102 With transverse striæ.

103 Smooth, with two dark bands.

104 Columella smooth.

105 Columella plicate.

106 Rising to an acute point, resembling varieties of N. versicolor, C. B. Ad., and N. ambigua, Mtg.

107 White, costate.

108 Finely transversely grooved and semicostate; is the N. maderensis. Reeve, pl. 27, f. 182. Madeira.

108A Gallandiana, Fisher. Jour. de Conch., 1860, p. 81, pl. 2, f. 6, Spain and Portugal.

108B A shell with close transverse striæ is figured in Savigny's Egypt, pl. 6, f. 3.

109 Tall, white, slightly spotted below the sutures, strongly variced.

110 Broader and somewhat granular, allied to N. pauperata, Lam.

111 Broad, strongly costate, ribs curved, closely lined transversely.

112 Broad, cancellated, is the N. cancellaria, Poties and Michaud, Gal. des Moll., p. 374, pl. 32, f. 3, 4.

113 Resembling some of the small varieties of N. costata, A. Ad. Reeve, pl. 21, f. 142.

114 Approaching in form and colour the N. gaudiosa, Hinds. "Voy. of the Sulp.," pl. 9, f. 16 (not Reeve!).

115 Cancellated. Captain Horsfall, Malta, Palermo, &c.

116 Closely and finely ribbed, of a pale greyish ash colour, closely allied to the varieties of N. planicostata, A. Ad..

117 With a broad dark brown central belt, dotted with white.

118 Having two belts, very like the N. zonalis, A. Ad.

119 Columella, deep orange.

120 Deformed, all the whorls are oblique.

121 Small, white, banded at the sutures; in great numbers, mixed with small varieties of N. mutabilis, Linn. Mediterranean.

122 Similar to the last, but very variable in colour. Keeling's Islands.

123 In form and colour resembling varieties of N. teretiuscula, A. Ad.

124 Small, smooth, costate throughout.

125 Tall, strongly costate, passing into the N. capensis, D'k'r.

126 A variety of N. glaberrima, Gmel.; is so like the next that if placed in the same box, they could not be distinguished from each other. Malta.

127 Delicata, A. Ad. P.Z.S., 1851. Reeve, pl. 27, f. 180. Philippines.

128 More elongated, ribs closer and more numerous. Ceylon.

129 With thick ribs, shell more elongated. S. Archer, Singapore.

130 Oblique, with three rows of nodules on the ribs.

131 Ribs spiny, shell more cylindrical than the last, resembling the N. echinata, A. Ad., but is more glossy.

132 Showing a close affinity with N. crenolirata, A. Ad.

133 Crenolirata, A. Ad. Reeve, pl. 25, f. 165. S. Archer, Singapore.

133A Shell twice the size of the last, and much more oblique.

134 Ribs spiny, as in N. muricata, Quoy and Gaim.

135 Showing both in form and colour an affinity with the N. complanata, Powis, varieties.

136 Passing into the N. Gruneri. Reeve, pl. 12, f. 78 (not Dunker!).

137 Shell buff, tip purple, without bands.

138 Smaller and banded, N. geniculata, A. Ad. Reeve, pl. 26, f. 171. Philippines.

139 Ribs smooth, distant, interstices very closely striated.

140 Large, with strong ribs, and prominent nodules.

141 Taller, narrower, semicostate, ribs smooth.

142 Labecula, A. Ad. P.Z.S., 1851, p. 98. Reeve, pl. 25, f. 166.

143 Fraterculus, Marr. Is very closely allied to N. sinusigera, A. Ad. It has a thick callous.

144 Narrower and more elongated than the last; is the N. fraudulenta, Marr. Pamphlet, p. 8, pl. 1, f. 24.

145 Mangelioides, Reeve, pl. 23, f. 152. Australia.

146 Corticata, A. Ad. P.Z.S., 1851, p. 98. Reeve, pl. 28, f. 189. New Zealand.

147 Nearly smooth.

148 Ribbed and banded with brown.

149 Body-whorl short, ribbed and noduled, brown, with a central white band; young shells have a crenated operculum; in old ones it is spiny.

150 Sinusigera, A. Ad. P.Z.S., 1851, p. 100. Reeve, pl. 17, f. 113. Philippines.

151 Shell larger, ribs more distant than the last, passing into small forms of N. costata, A. Ad.

152 Semicostate.

153 Nodules at the sutures very strong.

154 In form very like the Cyllene lyrata, Lam.

155 Strongly ribbed and transversely grooved.

156 Callous of the columella spreading, showing an approach to the N. callosa, A. Ad.

157 Ribs very close and numerous in front, the last or body-whorl has no groove below the suture.

158 Callosa, A. Ad. P.Z.S., 1851, p. 98. Reeve, pl. 28, f. 185. Is a variety of N. sinusigera, A. Ad., with an extended callous. Philippines.

159 Passing into the N. crenolirata, A. Ad.

160 Noduled on the ribs, passing into the N. nodicostata, A. Ad.

161 Nodules on the ribs much larger than the last, showing a relationship with the N. Gruneri, Reeve, (not Dunker!)

162 Is intermediate between the N. Gruneri, Reeve, and N. sinusigera, A. Ad.

163 Gruneri, Reeve, pl. 12, f. 75. Philippines.

164 Intermediate between the last and N. crenolirata, A. Ad.

165 Intermediate between N. crenolirata and N. corticata, A. Ad.

166 Shell with four nodular keels, each nodule is white and is connected with its nearest neighbour by a fine brown line.

167 Muricata, Quoy and Gaim. "Voy. de l' Astr.," pl. 32, f. 32, 33. Columella granular.

168 White, columella with three or four folds at the base.

169 Columella smooth, expanded. Reeve, pl. 11, f. 73. New Ireland, &c.

170 Intermediate between the last and N, horrida, D'k'r.

171 Ribs slightly nodose.

172 Ribs thin and distant.

173 More elongated, passing into the N. echinata, A. Ad.

174 Body-whorl short, spire elongated, noduled, not more than half the usual size.

175 White, with purplish-brown bands.

176 White, with a broad rufous band on the body-whorl, and a fine thread-like line of a similar colour at the suture.

177 Short and broad, resembling the N. Gruneri, D'k'r.

178 Strongly noduled, banded with purple, apex purple, as in N. geniculata, A. Ad.

179 Ribs rounded, passing into the N. pura, Marr.

180 Horrida, Dkr. Phil. Abbild., pl. 2, f. 8. =curta, Gould. Samoa Is.

181 Of a rufous brown, passing into N. muricata, Quoy and Gaim.

182 Shell elongated.

183 Short and broad. Reeve, pl. 11, f. 69. Andaman Islands.

184 Vibex, Reeve, pl. 12, f. 81. H. and A. Adams' Recent Mollusca, vol. 1, p. 121. (Not Say!) Philippines.

185 Subspinosa, Lam., vol. 10, p. 173. Kien., pl. 26, f. 103. Ditto.

186 Broad, nodules very prominent.

187 Shell more elongated, with two spiny keels.

188 Shell with three keels, probably the N. tricarinata, Lam.

189 Dark brown, banded with white.

190 Showing a close affinity with varieties of N. muricata, Q. and G.

191 Pale olive, banded with brown and white. A beauty!

192 The nodules connected by the ribs.

193 Is a tall form, with broad ribs, nodules fading.

194 Closely resembling the N. corticata, A. Ad.

195 Strongly ribbed, but only noduled at the sutures. Philippines.

196 Tall and elongated, slightly ribbed, covered with a brown epidermis

197 Lirella, Marr. Pamphlet, p. 6, pl. 1, f. 18. Philippines.

198 Whorls rounder, „ pl. 1, f. 19.

199 Brown, with a central white band, ribs smooth and shining.

200 Sculpta, Marr. Pamphlet, p. 5, pl. 1, f. 30. Philippines.

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201 Fossata, Gould. =Elegans, Reeve. Con. Syst., p. 234, pl. 268, f. 3, 1841-2. (Name pre-occupied by J. Sow., 1824). California.

202 Pagoda, Reeve. Triton, pl. 22, f. 97. Nassaria, H. & A. Ad. Hab. ?

203 Ribs wider apart, the transverse lines are very distinct. Gault. Test., pl. 51, f. 1.

204 Verrucosa, Gmel. Gault., pl. 43, f. M.

205 Ribs strong, shell much paler in colour. N. decussata, Reeve, pl. 18, f. 121. =canescens, C. B. Ad.

206 Similar to the last, but very pale, as if the colour had faded.

207 With the ribs as in the figure, Kiener, pl. 30, f. 3.

208 The ribs are obsolete on the back of the last whorl, transverse granular striæ very distinct.

209 Much more elongated, with very strong ribs and nodules.

210 Shorter and broader, like the shell figured by Kiener, but strongly noduled.

211 Corpulenta, C. B. Ad. Panama.

212 Rufolineata, Marr. =polygonata, Reeve, (not Lam.!) pl. 18, f. 123. Philippines.

213 Acuta, Carp't'r. Brit. Mus. Mazatlan Shells, p. 497.

214 Polygonata, Lam. Kien., pl. 29, f. 119.

215 Polygonata, D'Orb.; "Voy. dans L. Amer. Merid.," p. 433. West Indies.

216 Tritoniformis, Kien., pl. 30, f. 2; operculum triangular, crenated on one side. West Africa.

217 Large. Reeve, pl. 18, f. 120.

218 Short and broad, with strong varices; in the Collection of A. W. Langden, Esq., Hastings.

219 Very pale, almost white, columella callous, slightly expanded.

220 Narrow and elongated; this variety was named in the Brit. Mus., N. acinosa, Gould.

221 Small, passing into varieties of N. incrassata, Müll.

222 Ribs few and distant.

223 Incrassata, Müll. =ascanias, Brug.; Lacepedii and Ferrussaci, Payr.; macula, Mtg; minuta, Penn; and exilis, Gmel. Seas of Europe, &c.

224 Whorls granular, lip expanded, columella plicate, intermediate between the last and N. tritoniformis, Kien.

225 Broad, strongly ribbed and cross-grooved, passing into the varieties of N. tritoniformis, Kien.

226 Taller, lip expanded, Reeve, pl. 17, f. 114.

227 Similar to the last in form, but having oblique ribs.

228 Ribs oblique, whorls angular.

229 Whorls round, shell short, white, very thick, callous expanded.

230 Yellowish-brown, transversely lined, ribs oblique.

231 Shorter and broader than the last, lined and banded.

232 Of a pale rose colour, the ribs and outer lip are white.

233 Broad and short, passing into the varieties of N. ambigua, Mtg.

234 Rosacea, Lam. Reeve, pl. 27, f. 183.

235 Similar to the last, but strongly variced.

236 White, with broad, brown bands, apex pink.

237 Closely allied to varieties of N. Gayi, Kien.

238 Shell short, broad, thick, strongly ribbed and lined.

239 Dark brown, with a white central band, columella smooth, passing into the N. coccinella, Lam.

240 A short, broad, two banded variety.

241 Pale, with a brown, tessellated, central band, callous expanded. N. ascanias, Kien., pl. 26, f. 104.

242 Ribs oblique, callous more expanded than the last; is the N. coccinella, Lam. Kien, pl. 25, f. 98.

243 Intermediate between N. incrassata, Müll., and N. glaberrima, Gmel.

244 Dark brown, callous constricted; is the N. coccinella, Lam. Kien., pl. 20, f. 77.

245 Taller and more turreted than the last, strongly variced.

246 Tall, with transverse, wavy thread lines, columella wrinkled.

247 Similar to the last in form, but having a smooth columella.

248 Tall, with oblique ribs; it is about the size and closely resembles the N. asperula, Brocchi.

249 Resembling in colour, form, and in having broad bands, the N. miga, Adans.

250 Ribs and cross-grooves strongly marked.

251 Granules small, varices almost opposite to each other, like the Ranella; is the N. varicosa, Turton, N. pygmæa, Lam. Seas of Europe.

252 Smaller and much broader than the last.

253 Ferussacci, Payr., pl. 8, f. 15, 16.

254 More elongated than the last.

255 Lacepedii, Payr., pl. 8, f. 13, 14.

256 Narrow and elongated, rough, passing into the N. scabriuscula, Powis.

257 Whorls angular, dark brown, with a pale central band, rough.

258 Columella bright yellow, operculum crenated on the side next to the inner lip.

259 Broad, passing into the N. collaria, Gould.

260 Collaria, Gould. Reeve, pl. 25, f. 169. Panama.

261 With the upper whorls closely striated; is the N. crebristriata, Carpenter. Mazatlan Shells, p. 499. Panama.

262 Elongated, with strong white varices.

263 Ribs oblique, covered with a pale epidermis.

264 Broader and more cylindrical, is a shell figured in Mart. and Chem., ed. 2, pl. 6, f. 12, 13.

265 Finely granuled, passing into the N. multigranosa, D'k'r.

266 Whorls tumid, shell rather thin, N. multigranosa, D'k'r. Phil. Abbild. pl. 2, f. 13.

267 Thicker, whorls more regular than the last, granules larger; is the N. hotessieri, D'Orb. Cuba.

268 Lip and columella expanded, tapering to an acute point, resembling the N. nodulifera, Phil.

269 Encaustica, Brusina.

270 Gimmellari, Biondi. Jour. de Conch., vol. 7, p. 303. Is strongly ribbed and transversely striated.

271 Tall, thin, passing into and completely blending with the varieties of N. capensis, D'k'r.

272 Dark brown, white at the base.

273 Tall and narrow, of a beautiful rose colour.

274 Passing into the N. labiata, A. Ad.

275 Callandiana, Crosse. Jour de Conch., 1863, p. 81, pl. 2, f. 6.

276 Slightly plicate, shell very oblique; is the N. (Strombus) glabrata, Sow. Thesau. Conch., pl. 8, f. 66, 67.
=N. obliqua, Kien. West Africa.

277 Strongly plicate.

278 Banded with blueish grey, unspotted, columella and inner lip strongly plicate, showing a close affinity with the N. tænia, Gmel.; is the N. cærulea, Marr.

279 Intermediate between the N. incrassata, Müll., and the N. teretiuscula, A. Ad.

280 A variety passing into the N. plebecula, Gould, and closely allied to some of the tall forms of N. ambigua, Mtg. Spain, Portugal.

281 With the upper parts of the whorls strongly ribbed and the lower half striated.

282 Showing an affinity with the small forms of N. antillarum, Phil., and N. vibex, Say.

283 Short, broad, of a dark red-brown colour, with darker transverse thread-like lines.

284 Body-whorl smooth, ribs continuous; N. fuscolineata, Smith. Ann. and Mag. Nat. Hist., 1875, p. 323-4. Cape Sima.

285 Pusiola, D'k'r. Vitti Islands.

286 Propinqua, J. Sow. (Crag.), granular variety.
= semistriata, Brocchi; semistriated variety.

287 Elongated, pale, with pale rufous bands, N. trifasciata, A. Ad.

288 Closely striated all over the shell. Vigo Bay.

289 Granular; this is the recent form of the N. propinqua, J. Sow., from the Crag.

290 Longitudinally ribbed and transversely grooved.

291 Narrower and more elongated.

291A More fusiform than the figure in Brocchi's work. This is the common form. Vigo Bay.

291B Broadly ovate, semistriated.

292 Short and broad, equally grooved throughout, grooves distant.

293 Not more than a quarter of an inch long, ribbed and cancellated, similar to some of the varieties of N. marginulata, Lam.

294 Intermediate between the genus Nassa and Bullia.

295 Vincta, Marr. Pamphlet, p. 12, is a large elongated form, three banded, showing the passage of these shells into the pale varieties of N. sequijorensis, A. Ad.

296 Narrow and elongated, closely allied to the N. planicostata, A. Ad.

297 Narrow and elongated, closely allied to the N. corniculum, Olivi.

298 Allied to some of the brown varieties of N. pauperata, Lam.

299 A small beautifully variegated variety. Keeling's Islands.

300 Resembling the West African shell, the N. sesarma, Marr.

301 Small, elongated.

302 Small, very thick, noduled; is the N. pumilio, Smith. Whydah, W. Africa.

303 Narrow and elongated. Malta.

304 Closely allied to the last; is the N. Æthiopica, Marr. Pamphlet, p. 13. Kabenda, W. Africa.

305 Elongated, apex sharp.

306 Broader and much more tapering than the last; is the N. candei, D'Orb. Cuba, pl. 23, f. 1-6. Cuba.

307 Rubra, Poties and Michaud. Gall. des Moll., p. 381, pl. 32, f. 17, 18. Seas of Europe.

308 Very small, whorls very round, aperture round. Malta.

309 Compacta, Angas. P.Z.S., 1865, p. 154. St. Vincent's Gulf, Australia.

310 Minor, Marr. Pamphlet, p. 14. Kabenda, West Africa.

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311 Tænia, Gmel.; the smooth form. Reeve, pl. 3, f. 19. Philippines. =olivacea, Brug.

312 Smooth, rounded below the sutures, intermediate between the last and N. canaliculata, Lam. New Guinea.

313 Larger, with the whorls more regularly tapering than the last, olivaceous with irregular transverse bands. Gault., pl. 44, f. D.

314 With broad ribs. Kien., pl. 15, f. 53.

315 Smaller, with the ribs more regularly defined; is the N. approximata, Pease.

316 With close smooth ribs.

317 Much smaller.

318 Passing into the N. nodifera, Powis. It is impossible to say where the N. tænia ends and N. canaliculata, N. nodifera and N. trifasciata begin.

319 Cancellated. Quoy and Gaim., "Voy. de l' Astrolabe," pl. 32, f. 13-15. New Guinea.

320 Smaller, passing into the N. margaritifera, D'k'r.

321 Small, polished, ribs slightly raised, passing into the N. Kieneri, Anton. and N. coronata, Brug.

322 A small cancellated variety, shows a close affinity with the N. reticulata, Linn. New Guinea.

323 Elegans, Reeve (not Kien.!) pl. 2, f. 10. [Brug.

324 Smooth, coronated at the sutures, passing into the N. coronata,

325 Tumid and cancellated, but not coronated below the sutures. Marrat's Pamphlet, pl. 1, f. 12.

326 Tumid below the sutures, very large, nearly two inches long. This shell occupies a position so intermediate between N. tænia and canaliculata that it might with equal propriety be placed with either of them.

326A Passing into the N. nodifera, Powis.

327 Smooth, polished, oblong, passing into the N. oblonga, Marr.

328 „ more elongated, coronated at the sutures, all the whorls except the body-whorl costate.

329 Intermediate between N. tænia, Gmel., and nodifera, Powis.

330 „ „ and margaritifera, D'k'r.

331 „ „ and margaritifera, Reeve (not D'k'r.!)

332 „ „ and coronata, Brug.

333 Coronata, Brug. Reeve, pl. 3, f. 20. Reeve, Madagascar.

334 Spire elongated, callous very thick, shell heavy, deformed. A very interesting form.

335 With a double callosity and a double lip, deformed.

336 Very large, with an external central white band, and three in the interior of the shell.

337 With the upper whorls cancellated and the body-whorl plain.

338 Smooth and polished, scarcely coronated.

339 Large, very broad, semicostate, white, callous thin, the lip has folds behind it.

340 With strong ribs behind the thickened lip.

341 Smooth at the sutures, resembling varieties of N. mutabilis, Linn.

342 With the ribs placed at a distance from the outer lip.

343 Ribs short and strong.

344 Ribbed half way down the shell.

345 Bullata, Marr. Pamphlet, p. 5. Quoy and Gaim., "Voy. of the Astr.," pl. 32, f. 5-7. New Guinea.

346 Regularly costate, coronated at the sutures.

347 Intermediate between the N. coronata, Brug., N. Kieneri, Anton., and N. nodifera, Powis.

348 Marmorata, Anton. Verz. der Conch., p. 92, No. 2966. S. Archer, Singapore.

349 Marmorea, A. Ad. P.Z.S., 1851, p. 106. Reeve, pl. 1. f. 7. Philippines.

350 Marbled, but not banded. Dr. Collingwood, Borneo.

351 Tumidly coronated. Ditto.

352 With denticles in front of the lip.

353 Kieneri, Anton. Verz. der Conch., p. 92, No. 2965. = lurida, Gould. = dispar, A. Ad. New Guinea.

354 Turreted, very elongated. A deformity similar to the N. distorta and stolida, A. Ad.

355 Coronated, passing into the variety with small spots of N. coronata, Brug.

356 With white flames, exactly like those on the shells of N. coronata, Brug.

357 Passing into the N. bicallosa, Smith.

358 Bicallosa, Smith. Linn. Soc. Journ. Zool., vol. 12, pl. 30, f. 1. Swan River and Cape Natal.

359 Passing into the N. mutabilis, Linn.

360 With a thick round callous in front.

361 Passing into N. mucronata, A. Ad.

362 Between Kieneri, coronata and tænia.

363 „ and gaudiosa, Hinds.

364 „ and bicallosa, Smith.

365 Mutabilis, Linn. Reeve, pl. 1, f. 6. Mediterranean.

366 Covered with a silky epidermis. Taylor Collection.

367 Ebenacea, Gemari.

368 Pfeifferi, Phil., is transversely striated and interruptedly lined. Spain.

369 Elongated, narrow, and rather thick.

370 Small, about half an inch long, white, streaked with pale rufous-brown.

371 Two lines long, pale, almost white, lip thickened.

372 Tumidly coronated.

373 White, sutural edge somewhat angular, closely allied to the N. spirata, A. Ad.

374 Grey-brown.

375 White, with very faint markings.

376 With the upper whorls cancellated, spotted like the N. spirata, A. Ad. Singapore.

377 Between N. mutabilis, Linn., and N. marginulata, Lam.; granules at the sutures numerous.

378 Upper whorls and below the suture on the last or body-whorl deeply grooved transversely.

379 Brown spotted, flamed and banded with brown.

380 With strong varices.

381 With the ribs near the centre of the whorls.

382 Foliosum, Wood's Index, pl. 22, f. 39. Amboyna.

383 Algida, Reeve, pl. 22, f. 145. Moreton Bay, Australia.

384 Intermediate between the last and the N. elegans, Kien. (name pre-occupied).

385 Intermediate between the N. elegans, Kien., and N. lævigata, Marr.

386 Ferruginous brown, resembling the varieties of N. picta, D'k'r.

387 Resembling the N. foliosum, Wood, but spotted at the sutures.

388 Mutabilis, Wood, pl. 22, f. 47. Capt. Cawne Warren, Ceylon.

389 Bucculenta, Marr. (See description.)

390 Between N. compta, A. Ad., and N. elegans, Kien. Mauritius.

391 Between N. mutabilis, Linn., and marmorata, Anton.

392 Between N. mutabilis, Linn., and N. nodifera, Powis.

393 Nitidula, Linn. Chem., pl. 125, f. 1194-5. =Canaliculata, Lam.

394 Canal wide, shell rufous brown, almost smooth.

395 Canal partly open.

396 Canal closed, drab, with a brown-rufous stain on the back.

397 Canal closed, drab, with a brown-rufous stain, coronated at the sutures.

398 The upper whorls are costate, the body-whorl almost smooth, lip spiny.

399 Drab, with two brown bands, lip without spines.

400 Drab, with a single brown spot, suture plain, lip slightly crenated.

401 Shell smooth, passing into the N. trifasciata, Gmel.

402 Ash-grey, noduled at the sutures, strongly ribbed behind the lip, passing into the N. nodifera, Powis.

403 Ash-grey, noduled at the sutures, passing into the N. marginulata, Lam., and N. nodifera, Powis.

404 About half the size of the N. canaliculata, Lam., as figured in Reeve, finely plicated throughout. "Challenger" Ex.

405 Smaller than the last, smooth and glossy; closely allied to the N. lævigata, Marr.

406 Smooth and glossy; the ribs are but slightly developed in this variety.

407 Semi-cancellated. Reeve, pl. 3, f. 18. Philippines.

408 Closely cancellated, resembling the shell figured in Kien., pl. 14, f. 49, as N. crenulata, Brug., but broader. Indian Seas.

409 Canal slightly open. Mart. and Chem., ed. 2, pl. 7, f. 8-9.

410 Smooth, whorls round, ventricose.

411 Lævis, H. and A. Ad. (not Chem. !) Recent Mollusca, vol. 3, pl. 12, f. 7.

412 Trifasciata, Gmel., p. 3489. Gault. Test., pl. 44, f. A.
=rutilans, Reeve. New Holland.
=unicolora, Kien.

413 Broad, smooth, glossy; evidently the smooth form of N. canaliculata, Lam., and N. nodifera, Powis.

414 Unicolorata, Reeve, pl. 3, f. 17. Shell of a bluish ash colour. Jukes, N. Australia.

415 Unicolora, Kien., pl. 19, f. 69. Shell ashy-grey, narrow in form.

416 Ash, olive and grey; is the N. rutilans, Reeve, pl. 22, f. 147. New Zealand.

417 Of a rufous-brown colour.

418 With three internal brown bands. (Hence the name trifasciata.)

419 Elongately oblong, very fine.

420 Smaller and narrower, of a dark red-brown colour.

421 White.

422 Ash-grey, with two brown bands.

423 Orange, with ditto.

424 Oblong-ovate, pale in colour.

425 Resembling in form the N. sequijorensis, A. Ad. (I have no doubt of this being the smooth form of the shell named.)

426 Of a dark purple colour, both externally and internally.

427 Small, almost fusiform, showing its close affinity to N. micans, A. Ad.

428 Monile, Kien., pl. 11, f. 40. Pale, ribs smooth. Philippines.

429 Slate coloured, with darker bands. Reeve, pl. 6, f. 38.

430 Ash-grey, with darker bands.

431 Lip having sharp denticles on its edge.

432 „ without denticles.

433 Ribs strong, curved.

434 „ almost obsolete.

435 A distorted variety; is the N. distorta, A. Ad. Reeve, pl. 5, f. 32.

436 Another shell, the N. lachrymosa, Reeve, pl. 8, f. 52, is a smooth form.

437 One of the Australian varieties;' has been named N. Jacksoniana, Kien., pl. 19, f. 73.

438 Lined on the back of the lip, and otherwise very like varieties of N. picta, D'k'r.

439 A variety very closely approaching some of the shells of N. coronata, Brug.

440 Approaching forms of N. nodifera, Powis.

441 Closely allied to the N. mucronata, A. Ad. Shark's Bay.

442 Resembling in form and ribbing the N. costata, A. Ad.

443 Shell narrow, passing into the N. velata, Gould. Australia.

444 Nodifera, Powis. Reeve, pl. 4, f. 23. Panama.

445 Taller and more deeply canaliculate; colour pale purplish-brown and buff. New Guinea.

446 A large variety is figured in Gault. Test., at pl. 44, f. D.

447 Reddish-brown, as if iron-stained, callous expanded and thickened, closely resembling varieties of N. hirta, Kien.

448 Ash-grey, ribs close, sutures distinctly coronated, sulci between the ribs distant, callous almost obsolete.

449 Shell elongately ovate, callous defined, columella strongly plicate, on the front of the shell, the ribs are close and numerous.

450 Short, broad and rounded, banded with brown and white.

451 Ash-grey, strongly ribbed, carinated at the base, the inside is deep purple. New Guinea.

452 Resembling N. gemmulata, Lam., in form, ribs gracefully curved; the lower part of the body-whorl is closely granular. This shell combines the characters of the N. gemmulata, Lam., N. marginulata, Lam., N. nodifera, Powis, and N. costata, A. Ad.

453 With the upper whorls cancellated and the body-whorl strongly ribbed.

454 Shell passing into varieties of N. sequijorensis, A. Ad.

455 Ribs strong on each side of the shell, smooth in the centre, closely resembling a similar variety mentioned under the head of N. tænia, Gmel.

456 Shell coronated, ribbed in front, smooth at the back.

457 Ribs broad, shell cancellariform.

458 Elongated, strongly ribbed and coronated. S. Archer, Singapore.

459 Pale buff, almost white, with two broad pale ash bands, ribbed and coronated.

460 Interstices grooved, with two internal white bands on a brown ground. A beauty.

461 An elongated, strongly cancellated shell, resembling N. marginulata, Lam., passing into N. scalaris, A. Ad.

462 Smaller, ribs wider apart, scarcely cancellated, callous spreading.

463 Margaritifera, Reeve, pl. 9, f. 59, (not Dkr.!)

464 With the lip prickly in front with denticles.

465 A variety with the cancellation very fine, the transverse and longitudinal lines being hair-like, callous none.

466 Shell small, ribs distant, banded with brown and white. Ceylon.

467 Somewhat humpbacked, cancellated, callous covering the whole front of the shell. It came with the N. thersites, Brug., and is a cancellated variety of it. It is also the N. marginulata, Kien., pl. 29, f. 117.

468 Has smooth ribs, and resembles in form and colour the N. nivea, A. Ad.

469 Somewhat elongated, smaller than the last, ribs broad, resembling the N. Fontanei, D'Orb.

470 Ovate in form, approaching the N. oblonga, Marr.

471 Oblonga, Marr. Pamphlet, p. 5.

472 Shell fusiform.

473 Australis, A. Ad. P. Z. S., 1851, p. 272. Australia.

474 Intermediate between the last and N. livescens, Phil. S. Archer, Singapore.

475 Narrow, with the longitudinal and transverse lines very fine.

476 Livescens, Phil. Zeit. f. Malak, 1848, p. 135. Philippines.

477 Ribs broad, wide apart.

478 Hepatica, Pult. Wood's Index, pl. 22, f. 42.

479 Intermediate between N. livescens, Phil., and N. margaritifera, Reeve.

480 Shell deformed, having a thick piece of shelly matter cemented to the inner edge of the lip.

481 Between N. marginulata, Lam., and N. Australis, A. Ad.

482 Ribs wide apart, beaded at the sutures, smaller and broader than any of the foregoing varieties.

483 Shell smaller than the last, passing into the N. cælata, A. Ad. S. Archer, Singapore.

484 Broad, short, ribs very broad; this shell has the texture and is the colour of varieties of N. reticulata, Linn.

485 Having the granules formed by the transverse and longitudinal lines square.

486 Elongated, cancellation fine, approaching in colour, form and texture the N. sequijorenis, A. Ad.

487 In this variety the upper whorls are finely cancellated, and the body-whorl is coarsely granular.

488 Shell small, resembling in form, size and cancellation the N. cælata, A. Ad., but is grooved below the suture.
Philippines.

489 Resembling the N. fasciata, Lam., in colour, but is broader.

490 Nodules at the sutures large, showing an affinity with N. arcularia, Linn., var. pulla.

491 With the ribs continuous, scarcely grooved below the sutures.

492 Ribs broad, slightly raised, sutural granules white, interspaces red-brown.

493 Ribs close, coronation distinct, resembling a large N. costata, A. Ad.

494 Resembling No. 452, but more elongated and narrower.

495 Small, hump-backed, combining the characters of N. globosa, Q. and G., N. thersites, Brug., and N. marginulata, Lam.

496 More elongated than the last, passing into the N. leptospira, A. Ad.

497 Almost smooth, smoke-brown, callous thick, divided into two parts.

498 With the last whorl smooth behind the lip, resembling N. stolata, Gmel.

499 Semicostate, having the ribs only half their usual length.

500 „ elongated, polished, Gault. Test., pl. 43, f. P.

501 Smooth, highly polished, more or less coronated at the sutures.

502 In this shell the tubercles are elongated, forming short ribs.

503 Smooth, polished, without any sign of tubercles at the sutures, N. lævigata, Marr.

504 A variety of the last, with tubercles at the sutures. Marrat's Pamphlet, pl. 1, f. 7.

505 A variety of the last, with the tubercles elongated, semicostate.

506 Resembling No. 452 in form, but differs from that shell in being cancellated.

507 With irregular squares, formed by the transverse and longitudinal lines.

508 Whorls round, thick, resembling the N. hispida, A. Ad.

509 Is broader and more elongated than the last, resembling varieties of the N. reticosa, A. Ad. (Name pre-occupied by J. Sow.)

510 A variety closely allied to the N. splendidula, D'k'r., in both form and sculpture.

511 A variety in size and marking similar to the small N. gemmulifera, A. Ad.

512 Is an elongated, coronated shell, combining the character of five others—viz., N. elegans, Kein. (name pre-occupied by J. Sow., Min. Conch.), N. lævigata, Marr., N. coronata, Brug., N. trifasciata, Gmel., and N. nodifera, Powis.

513 Shell pale, ribs distant, smooth, closely allied to the N. bifaria, Baird.

514 Shell pale, ribs broad, glossy; between the N. bifaria, Baird, and N. costate, A. Ad.

515 Bifaria, Baird. New Caledonia.

516 With more numerous plicæ developed towards the base. Andaman Islands.

517 White, with two brown bands, ribs distant, very thin, the groove-line is close below the suture instead of distant from it.

518 Ribs smooth, whorls turreted, passing into the N. clara, Marr.

519 Labida, Reeve, pl. 27, f. 179.

520 Multicostata, A. Ad. P.Z.S., 1851, p. 98. Reeve, pl. 20, f. 136. Philippines.

521 Shell cream-coloured, with a central brown band, fusiform; is the N. pulcherrima, Marr. Pamphlet, p. 10, pl. 1, f. 15. New Holland.

522 Narrow and elongated, between narrow forms of N. nodifera, Powis, and N. planicostata, A. Ad.

523 Planicostata, A. Ad. P.Z.S., 1851, p. 108. Reeve, pl. 12, f. 76. Payta, Peru.

524 „ with much stronger ribs, pl. 14, f. 94.

525 Micans, A. Ad. P.Z.S., 1851, p. 106. Reeve, pl. 21, f. 140. Philippines.

526 Very narrow and elongated; N. terebroides, Reeve, pl. 24, f. 161. =costata, A. Ad. (name pre-occupied.)

527 Multilineata, Marr. Pamphlet, p. 11. South America.

528 Sparta, Mar. Pamphlet, p. 11, pl. 1, f. 22.

529 Anthracina, Garrett, Proc. Acad. Nat. Sci., Philad., 1873, p. 229, pl. 3, f. 57. Viti Islands.

530 Pupinoides, Reeve, pl. 24, f. 162. Philippines.

531 Marginulata, Reeve, pl. 7, f. 43. (Not Lamarck!)

532 „ „ pl. 8, f. 50. S. Archer, Singapore.

533 „ „ pl. 8, f. 51.

534 Marginulata, Lam. Kien. pl. 29, f. 117.

535 Closely allied to the last; is the N. venusta, D'k'r. Phil. Abbild., pl. 2, f. 1. Island of Bali, Indian Ocean.

536 Closely allied to the last; is the N. venusta, D'k'r. Reeve, pl. 7, f. 44. Philippines.

537 Ribs broader and wider apart than either of the two last-named shells.

538 Yellow, banded with blackish-brown fillets, similar to N. sturmii, Phil. Reeve, pl. 22, f. 148. Mozambique.

539 Shell smaller and paler, ribs more distant.

540 Ribs few, broad and noduled; is the N. sturmii, Phil. Abbild. pl. 1, f. 1.

541 With the ribs almost obsolete, passing into the next.

542 Shell broad and short; is the N. crassa, Koch. Phil. Abbild. pl. 1, f. 4. China.

543 White.

544 Crassa in form, and sturmii in sculpture.

545 „ and venusta in sculpture.

546 A variety with the ribs acute; is the N. acuticostata, Montrous. Jour. de Conch., 1864, pl. 10, f. 8. Caledonian Archipelago.

547 Is almost smooth.

548 Plicosa, D'k'r. Zeit., f. Malak, 1846. Algoa Bay, West Africa. =speciosa, A. Ad. P.Z.S., 1851, p. 100. Reeve, pl. 3, f. 16.

549 Upper whorls closely cancellated and the body-whorl smooth. Marrat's Pamphlet, pl. 1, f. 11. Algoa Bay.

550 An elongated shell, costate and strongly grooved. S. Archer, Singapore.

558 Narrow and elongated, passing into varieties of N. sequijorensis, A. Ad.

552 Oriens, Marr. China Seas. =elongata, Marr., Pamphlet, p. 4 (the name pre-occupied by J. Sow., Min. Conch.)

553 Smooth, costate, passing into the N. crassicostata, Marr.

554 Crassicostata, Marr. (See description, not the Pamphlet, p. 6). Bombay.

555 Smaller and more oblong than the last; is closely allied to the N. costata, A. Ad.

556 Costata, A. Ad. P.Z.S., 1851, p. 98. Reeve, pl. 21, f, 142. Philippines.

557 A variety resembling the N. nodicostata, A. Ad., but with smooth ribs.

558 Obesa, Neville. Jour. Asiat. Soc., p. 95, pl. 8, f. 2, 3. Bombay. var. Ceylonica. Ceylon and Penang.

559 Similar to the last in form, but having the ribs carried to the base. S. Archer, Singapore.

560 Bifaria, Baird. "Cruise of the Curacoa" (Brenchly), 1873, p. 436, pl. 38, f. 1, 2. Andaman Islands.

561 With longer ribs, showing a variation towards the N. pauperata, Lam.

562 Bella, Marr. Pamphlet, p. 9, has the ribs granular.

563 With a broad, button-like callous in front. N. præcallosa, Marr. Pamphlet, p. 11.

564 Concentrica, Marr. (as concinna, Powis). Reeve, pl. 13, f. 82. Philippines.

565 Wilsoni, Reeve, pl. 24, f. 158. (Not C. B. Adams.) The N. Wilsoni, C. B. Ad., is a variety of the N. complanata, Powis.

566 Between the N. concinna, Powis, and the next.

567 Smithi, Marr. Quart. Jour. Conch., Leeds, p. 187. Pamphlet, p. 7.

568 Between N. cribraria and concentrica, Marr.

569 Cribraria, Marr. Pamphlet, p. 12.

570 Abyssinica, Marr. „ p. 8. Abyssinia.

571 Grata, Marr. (See description).

572 Larger and broader than the shell described.

573 Taller and narrower than the last, whorls granular.

574 Small, reddish-brown, with a central, pale band.

575 Taller and narrower than the last, with the reticulation very fine.

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576 Arcularia, Linn. Reeve, pl. 4, f. 25*b*. Philippines.

577 White, glossy, body-whorl smooth in the centre, ribbed on each side.

578 Similar in form to the last, but cross-grooved, callous expanded.

579 Smooth, polished, strongly ribbed throughout, without the nodules at the sutures; is the N. plicosa, Bolton.

580 Strongly ribbed, but with very few cross-grooves, pure white inside and out.

581 Ashy-grey, spotted between the nodules. South Africa.

582 Darker in colour than the last, spots very pale.

583 Two-banded externally and three in the interior.

584 With a single external band and three inside.

585 Pale buff, with a broadly-expanded callous, like the Helmet Conch.

586 Yellow, tumid, double banded, sutures tumidly plicated, showing a tendency to run into the N. coronata, Brug.

587 Rufous-brown, the interior is brown with a central, narrow, white band.

588 Large, nodules prominent, olive-green. Reeve, pl. 4, f. 25*a*, callous much less expanded than is usual in these shells.

589 Callous less expanded, showing a close affinity with the N. marginulata, Lam.

590 A variety with an expanded callous; is figured in Kiener at pl. 28, f. 115.

591 Another variety with the cross-grooves interrupted; is figured in Mart. and Chem., ed. 2, pl. 4, f. 19, 20.

592 Ribs few and distant, shell white; is figured in Mart. and Chem., ed. 2, pl. 4, f. 21.

593 Pulla, Reeve, pl. 4, f. 22. Linnæus. (?) A cancellated variety of N. arcularia, Linn. Philippines.

594 White, with a central brown band and another of a darker colour below the sutures.

595 Crenulata, Brug. Ency. Meth., pl. 394, f. 6, exclusive of all synonymes.

596 Of a cream-colour, with very dark spots between the nodules, ribs broad; two of the ribs unite in one tubercle, and this occurs in the three first tubercles behind the lip.

597 Ribs very irregular, three of them join in the first tubercle, two and part of a third join at a little distance from the second, the remaining ribs are curiously curved.

598 White or very pale, cancellation very close. Red Sea.

599 Showing a close affinity with the N. perlata, Meuschen.

600 „ „ with the N. hispida, A. Ad.

601 Showing a close affinity with the varieties of N. thersites, Brug.

602 Very short and dumpy.

603 Spire elongated, acute, semicostate; a very curious shell.

604 Shell rather strongly ribbed, with numerous transverse hair-like grooves.

605 In this variety the upper whorls are closely cancellated, and the cancellation extends into at least one-half of the body-whorl, shell young.

606 Dark brown with a central white band.

607 Is small, with a rufous stain on the outer edge of the callous.

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608 Reticulata, Linn. Reeve, pl. 9, f. 57b. Seas of Europe.

609 Ribs more distant and fewer, f. 57a.

610 „ „ Kiener, pl. 23, f. 91. Mediterranean.

611 Closely resembling the small forms of N. tænia, Gmel. Malta.

612 Dark red-brown, nearly black, ribs broad and irregular, transversely grooved.

613 Dark red-brown, ribs granular, interstices deeply sulcate, callous yellow.

614 Dark red-brown, ribs smooth, interstices smooth, not grooved below the sutures; allied to the N. nodifera, Powis.

615 Variety nitida, Jeffreys, Brit. Conch. Britain.

616 Smaller than the last, ribs wider apart, banded with voilet, brown and white.

617 Narrow, conical, yellowish white.

618 Pale yellowish-white, with a dark-brown band below the sutures.

619 Broad, ribs very few, distant, body-whorl pale ash-grey, with interrupted brown transverse bands, having a strong varix.

620 Shell with the spire short and the body-whorl large, passing into the N. marginulata, Lam.

621 A small elongated form, resembling in both colour and marking the N. glaberrima, Chem.

622 Very long and narrow, white, indistinctly violet banded below the sutures.

623 Ribbed and cancellated, resembling the N. margaritifera, Reeve (not Dunker. !)

624 Ribbed and cancellated, resembling the N. margaritifera, D'k'r. =dentifera, A. Ad.

625 Is a very peculiar, short, broad form, with the callous covering the whole front of the body-whorl.

626 Grain ribbed, coronated, callous defined.

627 Banded with brown and white, with distinct varices.

628 Elongated, the ribs are obliquely and gracefully curved.

629 With irregular ribs closely packed behind the lip, then they become few and distant.

630 Granules very small, leaving an open space below the sutures, similar to the N. margaritifera, D'k'r.

631 Plicatella, A. Ad. P.Z.S., 1851, p. 111. Reeve, pl. 9, f. 56.

632 Intermediate between the last and N. limata, Chem.

633 Nivea, A. Ad. P.Z.S., 1851, p. 118. Reeve, pl. 18, f. 122.
Philippines.

634 Serrata, Brocchi. Sub-App. Foss., pl. 5, f. 4.
South European Seas.

635 Costulata, Brocchi ,, pl. 5, f. 9.

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636 Scalaris, A. Ad. P.Z.S., 1851, p. 108. Reeve, pl. 4, f. 21.
Philippines.

637 Is a smaller, narrower, and more elongated shell than the last.

638 Ash-grey, with two dark bands, showing a close affinity with varieties of N. canaliculata, Lam.

639 Having the ribs only slightly raised, resembling varieties of N. nodifera, Powis.

640 Resembling the shell figured in Kiener at pl. 14, f. 49, as a variety of the N. crenulata, Brug.

641 Canal almost closed, shell with two dark-brown bands.

642 Intermediate between N. scalaris, A. Ad., and N. canaliculata, Lam.

643 Variety deeply channelled at the suture, lip spiny; is very closely allied to the N. sequijorensis, A. Ad.

644 Passing into the N. oriens, Marr.

645 Elongated, spotted at the sutures, semicostate.
S. Archer, Singapore.

646 Varicifera, A. Ad. P.Z.S., 1851, pl. 108. Reeve, pl. 18, f. 118.
Eastern Seas.

647 A perfect specimen and fully matured; is much broader, lip much more expanded, than the figure in Reeve; the columella is almost smooth, callous covering about one-third of the body-whorl; operculum serrated; the only mature shell I have seen. China.

648 Tall and narrow; is very closely allied to the tall varieties of N. sequijorensis, A. Ad.

649 Small, with only one varix, passing into the N. cælata, A. Ad.

650 Crenulata, Brug. Ency. Meth., pl. 394, f. 6, is certainly a strongly-ribbed and closely-grooved variety of N. arcularia, Linn.

651 Crenulata, Kien., pl. 14, f. 49, is an ash-coloured shell with two pale bands, ribbed and grooved, lip without spines, and is allied to the N. sequijorensis, A. Ad.

652 A broader variety, Smith. P.Z.S., 1879, p. 120, pl. 20, f. 48. Japan.

653 Very finely cancellated, lip spiny, callous thin, spreading. Yokohama.

654 Of a dark, rufous-brown colour, cancellation rather coarse, shell broad and short, lip without spines, callous thick, not spreading. Japan.

655 Crenulata, Kien, pl. 23, f. 90, is certainly a variety of N. nodifera, Powis.

656 Crenulata, Chenu. Man. de Conch., p. 163, f. 169, is another variety of the same shell.

657 Crenulata, Reeve, pl. 1, f. 2, is allied to N. sequijorensis, A. Ad. Philippines.

658 Sequijorensis, A. Ad. P.Z.S., 1851, p. 97. Reeve, pl. 8, f. 53. Sequijor, Philippines.

659 With very close cancellation, of an ash-grey colour, lip spiny at the base. Japan.

660 White, with rufous bands, sutural canal wide open, passing into varieties of N. scalaris, A. Ad.

661 Intermediate between N. sequijorensis, A. Ad., and N. ravida, A. Ad.

662 Shell broader, ,, ,, and N. cremata, Hinds.

663 With distant ribs and only one or two transverse grooves.

664 Very elongated, resembling some of the varieties of N. trifasciata, Gmel.

665 Ribs distant, colour red-brown, passing into the varieties of N. nodifera, Powis.

666 Ravida, A. Ad. P.Z.S., 1851, p. 97. Reeve, pl. 11, f. 68, granules square. Philippines.

667 Ravida, A. Ad. P.Z.S., 1851, p. 97, granules round.

668 Intermediate between the last and N. reticosa, Hinds.

669 „ „ and N. splendidula, D'k'r.

670 Costate, with a few sulci in the interstices.

671 Passing into the N. cælata, A. Ad.

672 „ N. nivosa, Marr.

673 Clathrata. Born. Mus., p. 261, pl. 9, f. 17, 18.

674 Corrugata, A. Ad. P.Z.S., 1854, p. 110.

675 Shorter and broader; is the N. gemmulata, Lam. Reeve, pl. 5, f. 21. Captain Cawne Warren, Gulf of Manaar, Ceylon.

676 Papillæ large; is the N. verrucosa, A. Ad. (Not Gmel. !)

677 With the tubercles vaulted, so as to become almost spathulate. Philippines.

678 Ribs broad, regular. Kien., pl. 22, f. 84. Kiener, Indian Seas.

679 „ few and distant.

680 „ numerous and close.

681 Intermediate between N. gemmulata, Lam., and its variety N. verrucosa, A. Ad.

682 Intermediate between N. gemmulata, Lam., and its variety N. variegata, A. Ad.

683 Having a sharp, channeled spire.

684 Tubercles raised above the sutures, standing boldly out.

685 Smaller, less inflated, having the columelia granosely laminated; is the N. Cumingii, A. Ad. P.Z.S., 1851, p. 98. Reeve, pl. 5, f. 30. China.

686 Variegata, A. Ad. P.Z.S., 1851, p. 97. Reeve, pl. 11, f. 70. Philippines.

687 Intermediate between the last-named shell and the N. Keenii., Marr.

688 With small and numerous granules.

689 Crispata, Marr. Pamphlet, p. 14. In this shell the longitudinal lines are set upon the whorls almost as close to each other as it would be possible to place them, and being slightly raised, they have a crispate appearance.

690 Having no callous.

691 Stigmaria, A. Ad. P.Z.S., 1851, p. 96-7. Reeve, pl. 7, f. 42. Philippines.

692 Narrower and more elongated than the last. Philippines.

693 Smaller in all its parts; is the N. densigranata, Reeve, pl. 27, f. 181. Philippines.

694 Intermediate between the N. stigmaria, A. Ad., and N. splendidula, D'k'r.

695 Splendidula, D'k'r. Zeit. f. Malak, 1846, p. 170. Phil. Abbild., pl. 2, f. 16. Borneo.

696 White, tessellated with brown. A gem!

697 „ banded with rufous brown.

698 Elongated, showing an affinity with the N. Roissyi, Desh.

699 Short and broad, showing a close affinity to the N. variegata, A. Ad.

700 Small and narrow, approaching such shells as the N. nivosa, Marr.

701 Conoidale, Desh. Mart. and Chem., 2nd edit., pl. 8, f. 12-13. Island of Sunda.

702 Conoidale, Kien., pl. 27, f. 109, bis.

703 Intermediate between N. conoidale, Desh. and N. hispida, A. Ad.

704 „ „ „ and N. albescens, D'k'r.

705 Hispida, A. Ad. P.Z.S., 1851, p. 101. Reeve, pl. 6, f. 37 (young). Philippines.

706 Large, white, with prickly granules, interior yellow, with three brown bands.

707 With obtuse, blunt nodules.

708 With sharp nodular keels.

709 Coloured as in N. crenolirata, A. Ad.

710 Tall and elongated.

711 Short and broad.

712 Banded and dotted with ash-brown.

713 Columella strongly plicate.

714 „ almost smooth.

715 Short, passing into the N. Gruneri, D'k'r. (not Reeve!).

716 Taller „ N. splendidula, D'k'r.

717 Callous thick, broad and expanded, passing into the N. perlata, Meusch.

718 Between the N. marginulata, Lam., and N. hispida, A. Ad.

719 „ N. albescens, Phil., and „ „

720 With square granules.

721 Nodulosa, Marr. Pamphlet, p. 4. Ann. and Mag. Nat. Hist., 1873, p. 426; granules square, large.

722 Brychia, Watson, granules in parallelograms. 620 fathoms. Gomera.

723 Gruneri, D'k'r. (not Reeve!) Zeit. f. Malak., 1846, p. 171. Phil. Abbild., pl. 2, f. 2. Philippines.

724 Albescens, D'k'r. Zeit. f. Malak., 1846, p. 170. Phil. Abbild., pl. 2, f. 15. East Indies.

725 Granules coarser. Reeve, pl. 15, f. 100. Reeve, West Indies.

726 Whorls rounder than either of the two last-named shells; is the N. bicolor, Hom. and Jacq.

727 Isabellei, Reeve (not D'Orb.!), pl. 7, f. 47.

728 With large granules; is a white shell with a blue apex. Red Sea.

729 Sordida, A. Ad. P.Z.S., 1851, p. 97. Reeve, pl. 15, f. 96. Philippines.

730 Larger than the last, with rounder whorls. Moreton Bay, Australia.

731 Small, cancellation fine, callous spreading.

732 Another and still smaller variety; shows a close affinity with the N. Wilsoni, Reeve (not C. B. Ad.!).

733 Ribs strong, white, marbled with red-brown, apex brown.

734 Taller and more elongated than the last, passing into the smaller varieties of N. marginulata, Lam.

735 Gemmulifera, A. Ad. P.Z.S., 1851, p. 99. Reeve, pl. 20, f. 132. Philippines.

736 Acinosa, Gould. Pro. Bost. Soc. Nat. Hist., May, 1849.

737 Totombo, Adans., Sen. Senegal.

738 Turbinea, Gould. Liberia, West Africa.

739 Keenii, Marr. Pamphlet, p. 15. Philippines.

740 Persica, v. Mart.
=Deshayesiana, Issel.

741 Webbei, Petit. Jour. de Conch., 1850. Marrat's Pamphlet, pl. 1, f. 16. West Africa.

742 Ringens, A. Ad., (Not Desmoulea!) Reeve, pl. 29, f. 190; is closely allied to the last.

743 White variety.

744 Cremata, Hinds. (Not Reeve!) "Voy. of Sulph.," pl. 9, f. 8, 9, not square grained.

745 Smaller, narrower, and more elongated than the last.
Philippines.

746 Cremata, Reeve, (Not Hinds!), pl. 4, f. 26, square grained.
Reeve, Straits of Malacca.

747 Ravida, A. Ad. P.Z.S., 1854, p. 97. Reeve, pl. 11, f. 68.
Philippines, &c.

748 White variety, „ „ pl. 11, f. 74.
Philippines, &c.

749 Reticosa, A. Ad. (Name pre-occupied by J. Sow., Min. Conch). Apical-whorls brown.

750 Between N. reticosa, A. Ad. and N. Roissyi, Desh. Apical whorls white.

751 Between N. reticosa, A. Ad. and N. ravida, A. Ad.

752 „ „ and sequijorensis, A. Ad.

753 „ „ and cremata, Hinds.

754 „ „ and cælata, A. Ad.

755 „ „ ravida and sequijorensis, A. Ad.

756 Broader than N. ravida, A. Ad., and without a callous.

757 Narrower and more elongated than N. ravida, A. Ad.

758 Red-brown, with two darker bands, much smaller than N. ravida, A. Ad. There are four of these shells, all differing in form.

759 Sinensis, Marr. Pamphlet, p. 4. Capt. Denecke, Chinese Seas.

760 Short, broad, about one-half the size of N. ravida, A. Ad., with large granules.

761 Cælata, A. Ad. P.Z.S., 1851, p. 97. Reeve, pl. 20, f. 133.
Philippines.

I cannot regard the character of the elongated granules as being of any importance, scarcely any two of the shells otherwise identical with it have the line below the sutures equidistant from the sutural nodules.

762 Shell broader than the last, ribs sharply defined, rather distant, white, with a fine brown central line and a broad brown band near the suture.

763 Yellow, with two pale bands.

764 Clara, Marr. Pamphlet, p. 7; is white, with two pale brown bands, and is deeply grooved between the ribs.

765 Smaller and narrower than the last; N. rugosa, Marr. Pamphlet, p. 5.

766 Intermediate between the N. cælata, A. Ad., and small varieties of N. marginulata, Lam.

767 A small, dumpy form, passing into the N. globosa, Quoy and Gaim.

768 Lactea, Marr. (See description), is thin, white, with a turreted spire, evidently one of the deep water shells.

769 Narrow varieties pass into the N. livescens, Phil., small forms.

770 Passing into the N. Australis, A. Ad.

771 Smaller, thicker, and more turreted, passing into the N. rugosa, Marr.

772 Spilus, Watson. (Shells of the "Challenger" Ex). 155 fath. A thin, hyaline shell. Rain Island, Torris Straits.

773 Crenellifera, A. Ad. P.Z.S., 1851, p. 99. Reeve, pl. 8, f. 49.

774 Sprela, Watson. (Shells of the "Challenger" Ex.) 12-20 fath. Amboyna.

775 A small, cancellated, greyish-white shell. N. pusilla, Marr. (See description). Surgeon-Major S. Archer, Singapore.

776 Shell about a quarter of an inch long, between the small varieties of N. cremata, Hinds, and N. abyssicola, A. Ad.

777 Abyssicola, A. Ad. P.Z.S., 1851, p. 100. Reeve, pl. 26, f. 175. Philippines.

778 Granulosa, Marr. (See description.) A beauty. Taylor Collection. Philippines.

779 Like the N. cremata, Hinds, but having the longitudinal lines very fine and raised.

780 Sequijorensis, A. Ad., the cancellated form. Reeve, pl. 8, f. 53. Philippines.

781 Closely ribbed, with a few grooves between the ribs.

782 Very closely ribbed and cross-grooved.

783 Dark rufous-brown, whorls rounded.

784 Of a cream colour, with three pale rufous bands, sutures deeply channeled, passing into the variety N. trifasciata, A. Ad.

785 Similar to the last, but having the suture almost closed.

786 Resembling the two last, but very elongated.

787 With smooth ribs.

788 Broader, passing into the N. nodifera, Powis.

789 Nivosa, Marr. Pamphlet, p. 9. White, cancellated, coronated at the sutures.

790 Transversely spirally grooved; is the N. insculpta, Carptr. 40 fath. California.

791 Fissilabris, A. Ad. P.Z.S., 1851, p. 99. Reeve, pl. 21, f. 138. Philippines.

792 Glauca, C. B. Ad. Panama Shells, p. 61. Reeve, pl. 21, f. 139. Panama.

793 Parva, Marr. (See description.) Australia.

794 Albipunctata, Reeve, pl. 21, f. 144.

795 Roissyi, Desh. Kien., pl. 21, f. 82. Another specimen, with the operculum crenated on the side next the labrum has just been received from Surgeon-Major S. Archer, Singapore.

796 Pauperata, Lam. Vol. 10, p. 183. Reeve, pl. 5, f. 27. Australia.

797 White.

798 Brown.

799 „ with two darker brown bands.

800 Yellow, with a central brown band.

801 Ribs smooth, with a few scattered sulci in the interstices.

802 Strongly grain-ribbed.

803 Semicostate.

804 Narrow, passing into the N. Gayi, Kien.

805 „ passing by imperceptible gradations into the N. semigranosa, D'k'r.

806 Large, passing into the N. dentifera, Powis.

807 Strongly coronated, passing into the N. marginulata, Lam.

808 Resembling in form the Cyllene lyrata.

809 Gayi, Kien., pl. 21, f. 79. Reeve, pl. 13, f. 87. =rubritincta, Gould. Capt. Whiteway, near Valparaiso.

810 Inner lip smooth, operculum plain.

811 „ grooved, operculum crenated.

812 Shell dark purple-brown, operculum serrated; N. lilacina, Gould.

813 White, dotted with red-brown.

814 Tall and elongated, almost smooth.

815 Short and broad, passing into the N. Woodwardi of Authors (Not Forbes).

816 Passing into the N. pauperata, Lam.

817 „ N. incrassata, Müll.

818 Coronated at the sutures, showing an affinity with N. fasciata, Lam.

819 Whorls rounder than is usual, white, slightly stained with pale brown, ribs very oblique.

820 Tæniolata, Phil. Captain Whiteway, Valparaiso.
=Woodwardi of Authors. (Not Forbes).

821 White, with two brown bands.

822 White, covered with a pale grey epidermis.

823 Passing into the small granular forms of N. pauperata, Lam.

824 „ „ „ N. Gayi, Kien.

825 Almost smooth, merely exhibiting the lines of growth.

826 Semigranosa, D'k'r. Zeit. f. Malak., 1846, p. 170.

827 Optata, Gould. A variety of the above. Sydney Harbour.

828 Another slightly deformed shell; is the N. munieriana, Crosse.

829 Between N. semigranosa, D'k'r., and tæniolata, Phil. Peru.

830 Reata, Gould. Proc. Bost. Soc. Nat. Hist., 1860. Loo Choo.

831 Red-brown, ribbed longitudinally and grooved transversely; between N. semigranosa, D'k'r., and N. pauperata, Lam.

832 Grained throughout, passing into N. pauperata, Lam.

833 Showing a close affinity with the N. nodicincta, A. Ad.

834 Transparent white, strongly grain-ribbed. Australia.

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835 Corrugata, A. Ad. P.Z.S., 1851, p. 100.

836 Verrucosa, Gmel., p. 4427. Gault., pl. 43, f. M.

837 White, obliquely costate, showing a rather close relationship with such shells as the N. clathrata, Born.

838 Denticulata, A. Ad. P.Z.S., 1851, p. 110. "There is some resemblance in the general aspect of this species to young specimens of the common Buccinum undatum."—*Reeve*.

839 Prismatica, Brocchi. Sub. App. Foss., pl. 5, f. 7. Recent and fossil. Mediterranean.

840 Limata, Chem., pl. 188, f. 1808-9. „

841 Narrower and more turreted than the last, of a reddish-brown colour, spotted with white.

842 Strongly ribbed and tumidly noduled, with rufous spots between the nodules.

843 Resembling the N. conferta, Martens.

844 Scalariformis, Valenc. Kien., pl. 21, f. 80.
Kiener, Indian Ocean.

845 Resembling the variety of N. gaudiosa, Reeve, pl. 13, f. 85.

846 Between the N. limata, Chem., and N. versicolor, C. B. Ad.

847 Plicatella, A. Ad. P.Z.S., 1851, p. 111. Reeve, pl. 9, f. 56.

848 A shell embracing the characters of the N. prismatica, Brocc., N. nivea, A. Ad., and plicatella.

849 Perpinguis, Hinds, granules fine and close, as in the figure "Voy. of the Sulph.," pl. 9, f. 12-13. California.

850 Broad, whorls round, shell much shorter than the last; very like the figure in Chemnitz, pl. 124, f. 1164.

851 Coarsely granular, resembling a large N. trivittata, Say.

852 Pyramidalis, A. Ad. P.Z.S., 1851, p. 113. Reeve, pl. 29, f. 191. The shell from which Reeve's figure is taken is a much worn and bad specimen. It is very like a small specimen of Buccinum undatum, Linn., var. glaciale; beautifully variegated. Port Elizabeth, Africa.

853 White, with a few broad distant ribs; the upper whorls are cancellated, the body-whorl is slightly striated transversely. Labelled, Mediterranean.

854 Picturata, Marr. (See description.) Taylor Collection.

855 Proxima, C. B. Ad. Panama Shells. Ann. and Lyc. New York. Panama.

856 Versicolor, C. B. Ad. „ p. 66. Panama.

857 A little more elongated; is the N. rufocincta, A. Ad. P.Z.S., 1851, p. 106. Reeve, pl. 17, f. 112. Dyson, Honduras.

858 Lucida, Marr. Ann. and Mag. Nat. Hist., 1874; yellow-brown, with white ribs.

859 A semicostate variety.

860 With few and distant ribs.

861 Argentea, Marr. Pamphlet, p. 9. Whydah, West Africa.

862 Between N. versicolor, C. B. Ad., and N. Sanctæ-Helenæ, A. Ad. St. Helena.

863 Sanctæ-Helenæ, A. Ad. P.Z.S. Reeve, pl. 28, f. 188.

864 Intermediate between the last and the following shells—

865 Striata, Reeve (not C. B. Adams!), pl. 27, f. 177;

866 Between N. versicolor, C. B. Ad. and N. sinusigera, A. Ad.;

867 „ N. sinusigera, A. Ad., and fraudulenta, Marr.

868 Regulare, Kuster. Mart. and Chem., ed. 2nd, pl. 12, f. 23,4. Cape of Good Hope.

869 Sculpta, Marr. (See description.) S. Archer, Natal.

870 Undata, Marr. Pamphlet, p. 9. Resembles a miniature form of Buccinum undatum, Linn.

871 Trivittata, Say. Invert. Mass., p. 364, pl. 632.
Brant Point, Halifax, Georgia, etc.

872 Gibbsii, Cooper; is an intermediate form between the last and following shells— Puget Sound.

873 Mendica, Gould. Ditto.

874 With three rufous bands (hence the name N. trivittata) as in fasciata, Lam., and otherwise very like young specimens of it. "Specimens from Nantucket have the inner margin thickly coated to a considerable extent with enamel, while those found near Boston have none."—*Gould.*

875 Narrow and more elongated.

876 Fasciata, Lam., vol. 10, p. 169. Reeve, pl. 6, f. 40. Australia.

877 A large white variety, with large granules.

878 Quoy and Gaim. "Voy. de l'Astr.," pl. 32, f. 18-21.

879 Reddish-brown, with pale bands. Port Adelaide.

880 Short, broad, pale yellow with a narrow brown band.

881 Young, resembling varieties of N. trivittata, Say.

882 White, with very dark brown bands.

883 ,, neither spotted nor banded.

884 Tubercles on the columella almost obsolete; the inner edge of the lip is plain.

885 Columella smooth.

886 ,, with a single row of nodules.

887 ,, ,, double ,,

888 With somewhat square nodules.

889 Banded with red, brown, and white.

890 Closely granular, whorls rounded; is the N. spurca, Gould. Proc. Bost. Soc. Nat. Hist., 1860. St. Simon's Bay.

891 Intermediate between N. fasciata, Lam., and N. caperata, Phil.

892 Caperata, Phil., Abbild., pl. 2, f. 18. Philippines.

893 Passing into the varieties of N. pauperata, Lam.

894 Deshayesii, Homb. and Jacq.

895 Nodulifera, Phil., Abbild., pl. 1, f. 3.

896 Whorls more regular and less noduled.

897 Ribs oblique, resembling the narrow forms of N. miga, Adams.

898 More elongated, passing into the varieties of the N. incrassata, Müll.

899 Angulifera, A. Ad. P.Z.S., 1851, p. 109. Galapagos Islands.

900 Without the angle. Marrat's Pamphlet, pl. 1, f. 29.

901 Similar to the last, but having prominent teeth on the lip; is the N. acutidentata, Smith. P.Z.S., 1879, p. 212, pl. 20, f. 46.

902 Very closely ribbed and cross-grooved.

903 Between N. angulifera, A. Ad., and N. unifasciata, Peace.

904 Persica, v. Marten's.

905 Japonica, A. Ad. P.Z.S., 1851, p. 110. Japan.
=tenuis, Smith.

906 Angulata, Thorpe. China.

907 Ribs smooth, interstices very finely striated. Do.

908 Cochinensis, Thorpe. Do.

909 Shell narrow, tall, white, transversely grooved throughout, punctured in the grooves.

910 Echinata, A. Ad. P.Z.S., 1851, p. 101. Reeve, pl. 20, f. 131. Philippines.

911 Var. Smith. Shorter, with fewer tubercles.

912 Nodicincta, A. Ad. P.Z.S., 1851, p. 110. Galapagos Islands.

913 All the whorls but the last or body-whorl closely striated.

914 Ribs smooth.

915 Large, ribs strongly developed; this is closely allied to the N. versicolor, C. B. Ad.

916 With transverse reddish lines occurring at regular intervals, smooth and polished.

917 Grooved throughout.

918 Brown and white, with a few distant, reddish, transverse lines.

919 Plebecula, Gould. Japan.

920 A variety of the last, with numerous brown lines between the ribs.

921 Having the ribs projecting at the sutures.

922 Babylonica, Watson. Ribs raised into blunt tubercles at the sutures. Philippines.

923 Columella without a callous.

924 Callous not spreading.

925 „ smooth.

926 „ spreading, rugose.

927 Outer lip strongly toothed.

928 „ slightly toothed.

929 „ lirate.

930 Luteola, Smith. P.Z.S., 1879, p. 212, pl. 20, f. 47.
Goto Islands, Japan.

931 Unifasciata, Pease. Japan.

932 Bibalteata, Pease.

933 Narrower and more cylindrical than the last, whorls carinated.

934 Gracilis, Pease.

935 Fraterculus, D'k'r. Japan.

936 Similar in form, but twice as large, and rougher.

937 Microstoma, Pease.

938 Eximia, H. Ad. P.Z.S., 1872, pl. 3, f. 28. New Hebrides.

939 Woodwardi, Forbes. P.Z.S., 1850, pl. 11, f. 3. Sandwich Is.

940 Dermestina, Gould. Proc. Bost. Soc. Nat. Hist., 1860. Kikaia.

941 Small, white, elongated; between the last and N. striata, Reeve.

942 White, with large tubercles on the lip.

943 Brown.

944 An elongated variety.

945 Banded, passing into the N. scabriuscula, Powis.

946 Another variety, showing its close relation to the N. incrassata, Müll.

947 Tringa, Souverbie. Jour. de Conch., vol. 12, pl. 10, f. 7. These shells, commencing with the N. plebecula, Gould, and finishing with the N. tringa, Souv., are varieties of each other; they are also varieties of the N. incrassata, Müll.

948 Pura, Marr. Pamphlet, p. 13. Nassau, West Indies.

949 Intermediate between the last and the next. „

950 Ambigua, Mtg. Reeve, pl. 28, f. 187. „

951 White.

952 „ with strong and distant ribs.

953 „ similar to the last, but very acute at the apex.

954 Tapering to a sharp point, strongly striated.

955 Obtusata, A. Ad. P.Z.S., 1851, p. 130. Reeve, pl. 20, f. 135.
Philippines.

956 Between N. ambigua, Mtg., and N. obtusata, A. Ad.

957 „ „ and annellifera, Reeve.
West Indies.

958 Annellifera, Reeve, pl. 25, f. 168.

959 Between the last and the next.

960 Antillarum, D'Orb. (not Philippi!) Cuba, pl. 23, f. 1-3. West Indies.

961 Candei, D'Orb. Cuba, pl. 23, f. 4-6. „

962 Paupera, Gould. Upolu and Tongatabou.
=Samoensis. D'k'r.
=Striata. C. B. Ad.

963 Is white, taller, and more acute than the last.

964 Passing into the N. incrassata, Müll.

965 Paucicostata, Marr. Pamphlet, p. 11. Ribs few and distant. Nassau, West Indies.

966 Ribs distant, transverse sulci equi-distant.

967 Much broader than the last.

968 Rotundicostata, Marr. Pamphlet, p. 8.

969 Clathratula, A. Ad. P.Z.S, 1851, p. 99. A very beautiful shell. Philippines.

970 Much narrower and more elongated than the last.

971 Laticostata, Marr. Pamphlet, p. 12-13.

972 Quinquecostata, Marr. (See description.)

973 Nucleolus, Phil. Abbild., pl. 1, f. 8. Mazatlan.

974 A variety of the last; is the N. cinctella, A. Ad. P.Z.S., 1851, p. 110. Reeve, pl. 26, f. 176. St. Helena.

975 Jonasi, D'k'r. Phil. Abbild., pl. 2, f. 10.

976 Burchardi, D'k'r. „ pl. 2, f. 14. Port Adelaide.

977 Intermediate between the last shell and N. semigranosa, D'k'r. Australia.

978 Sanctæ-Helenæ, A. Ad. P.Z.S., 1851, p. 110. Reeve, pl. 28, f. 186. St. Helena.

979 Nucleolus, Reeve (not Phil.!), pl. 27, f. 178.

980 Nigella, Reeve, pl. 26, f. 173. New Zealand.

981 Nivosa, Marr. Pamphlet, p. 9.

982 Hottessieri, D'Orb. Cuba, pl. 21, f. 40-42. West Indies.

983 Multigranosa, D'k'r. Phil. Abbild., pl. 2, f. 13. East Indies.

984 Quantula, Gould. Pro. Bost. Soc. Nat. Hist., 1861. St. Simon's Bay.

985 A large grained white shell, with strong projecting teeth, similar to those in the N. abyssicola, A. Ad.

986 Whorls carinated, shell of a buff colour.

987 „ round, white, translucent.

988 Between N. thersites, Brug., and the next.

989 Stolata, Gmel., p. 3496-7. Mart. Conch., vol. 4, pl. 124, f. 1167-9. Wood's Index, pl. 23, f. 120.
S. Archer, Singapore.
=ornata, Kien. Ceylon.

990 White, with two broad brown bands.

991 „ a narrow central band.

992 Small, passing into the N. tiarula, Kien.

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993 Luteostoma, Brod. and Sow. Reeve, pl. 10. f. 63. Panama.
=xanthostoma, Gray. Reeve, Senegal.

994 Nodules very large and distant. Mazatlan.

995 „ rather close and numerous.

996 Transverse striæ almost obsolete.

997 Shell smaller, transverse striæ sharply defined, front pale yellow.

998 The whole callous is of a dark smoke-brown colour.
Mazatlan.

999 Passing into the N. antillarum, Phil., enamel white.

1000 Short, dumpy, nodules few, very large, oblique, callous of a chrome yellow colour.

1001 Antillarum, Phil. Zeit. f. Malak., p. 139, 1848. Abbild., pl. 1, f. 2. West Indies.

1002 Dark, with a central pale band. Reeve, pl. 12, f. 77.

1003 Smaller; is the N. ciniscululus, Reeve, pl. 22, f. 146.
St. Thomas, West Indies.

1004 Small, ribs strongly noduled, yellow with a few transverse red-brown lines.

1005 Shell passing into the N. acuta, Say (not Carp't'r. !)
Dyson, Honduras.

1006 Tall, narrow, and small, showing a close affinity with the N. mœsta, Hinds.

1007 Whorls round, ribs granular, passing into narrow varieties of N. dentifera, Powis.

1008 Keeled in the centre of the whorls.

1009 Buff, with red-brown interrupted transverse bands. Reeve pl. 17, f. 115.

1010 Tessellata, Reeve, pl. 25, f. 167; is simply a variety of the N. vibex, Say.

1011 Ribs numerous, granules dark brown, with a pale central band, callous thick, not spreading; is an intermediate form between N. antillarum, Phil., and N. crassa, Koch., varix behind the lip very strong.

1012 Acuta, Say, passing into the N. vibex, Say.

1013 „ „ N. antillarum, Phil.

1014 Tall and semicostate, passing into the N. jacksoniana, Quoy. and Gaim. "Voy. de l' Astr.," pl. 32, f. 28-29 (not Kien.!)

1015 Similar in form and colour to the N. tegula, Reeve.

1016 Tiarula, Kien., pl. 30, f. 4.

1017 Coronula, A. Ad. P.Z.S., 1851, p. 96. Philippines.

The N. tegula, Reeve, is a variety of the N. tiarula, Kien., and the N. coronula, A. Ad., is a strongly-ribbed variety of the same shell.

1018 Jacksoniana, Quoy and Gaim. "Voy de l' Astr.," pl. 32, f. 28, 9. Port Jackson, Australia.

1019 Very dark, banded, covered with a dark epidermis. S. Archer, Singapore.

1020 White, banded with brown. „

1021 Of a yellowish slate colour, banded with brown. Quoy and Gaim., Port Jackson.

1022 Closely allied to the N. corticata, A. Ad.

1023 Small, dark brown, strongly ribbed, ribs granular.

1024 Tall, callous pale yellow.

1025 Callous surrounded by a rufous ring.

1026 Narrow and elongated, ribs granular, passing into the following shell. S. Archer, Kauson Creek, Brit. Honduras.

1027 Fida, Reeve, pl. 13, f. 88.

1028 Vibex, Say. Jour. Acad. Nat. Sci., 11, 231. Invert. Massach., p. 364, f. 628 (not Reeve!)

"Broad, with a dark band at the top, on the middle, and at the front of the body-whorl."-- *Gould.*

1029 Fratensis, Perkins. Newhaven.

1030 The varieties of N. Jacksoniana, with sharp ribs, pass into the N. acuticostata, Montrouz, and the broad forms of it show a close affinity with the small varieties of N. stolida, Gmel.

1031 Thersites, Brug. Ency. Meth., pl. 394, f. 8. Reeve, pl. 10, f. 65.

1032 Very dark brown, with a pale band, a large variety.

1033 Pale, almost white.

1034 Columella white.

1035 „ yellow.

1036 „ dark smoke-brown.

1037 Surrounded by a rufous ring. S. Archer, Singapore.

1038 Shell covered with a brown epidermis. „

1039 Passing into the N. marginulata, Lam.

1040 Strongly ribbed behind the hump on the back. Philippines.

1041 Ribbed and cross-grooved. Captain Cawne Warren, Ceylon.

1042 Shell with the back scarcely humped, closely cancellated; this is similar to the specimen figured in Kiener, pl. 29, f. 117, as the N. marginulata, Lam.

1043 Very much elongated, resembling a large N. leptospira, A. Ad.

1044 Small; is the N. thersites, Quoy and Gaim. "Voy. de l' Astr.," pl. 32, f. 22, 3. New Guinea.

1045 Ash-coloured, with very dark bands. „

1046 Leptospira, A. Ad. P.Z.S., 1851, p. 103. Reeve, pl. 13, f. 84. Philippines.

1047 Between the last and N. pulla, Linn. (?). =globosa, Q. and G.

1048 Without the hump on the back; N. granifera, Kiener, pl. 27, f. 108.

1049 Back smooth and glossy.

1050 Pulla, Linn. (?). Gault., pl. 44, f. N. Operculum triangular, serrated on two sides. New Zealand. =globosa, Quoy and Gaim. "Voy. de l' Astr.," pl. 32, f. 25, 6. Operculum abnormal.

1051 Callous projecting and nearly covering the whorls, showing an affinity with the N. Kraussiana, D'k'r.

1052 Passing into the N. leptospira, A. Ad.

1053 Bellula, A. Ad. P.Z.S., 1851, p. 102. Reeve, pl. 28, f. 184. Philippines.

1054 Nana, A. Ad. P.Z.S., 1851, p. 102. „ pl. 25, f. 164. Philippines.

1055 Fraudulenta, Marr. Pamphlet, p. 8. Philippines.

1056 More elegant and much narrower than the last. „

1057 Dorsuosa, A. Ad. P.Z.S., 1851, p. 102. Reeve, pl. 21, f. 141.

1058 Thersites, Brug.; variety short and broad, passing into the next.

1059 Bimaculosa, A. Ad. P.Z.S., 1851, p. 102, 3. Reeve, pl. 10, f. 61. Philippines.

1060 Without the spots.

1061 With the back of the shell resembling, and that very closely, the back of N. crassa, Koch.

1062 Shell almost smooth.

1063 „ strongly ribbed.

1064 „ cancellated.

1065 „ a small variety; is the N. emersa, Carp't'r., Brit. Mus.

1066 Callospira, A. Ad. P.Z.S., 1851, p. 102. Reeve, pl. 10, f. 66. Apex decollated. Philippines.

1067 Cancellata, A. Ad. P.Z.S., 1851, p. —. Reeve, pl. 23, f. 155. Philippines.

1068 Callosa, A. Ad. P.Z.S., 1851, p. —. Reeve, pl. 28, f. 185.

1069 Jonasi, D'k'r. Phil. Abbild., pl. 2, f. 10.

1070 Labecula, A. Ad. Reeve, pl. 25, f. 166. Australia, Philippines, &c.

1071 Mangelioides, Reeve, pl. 23, f. 152.

1072 Gibbosula, Linn. Variety with two prominent nodules on the back, olive, freckled with bluish-white. Reeve, pl. 10, f. 64. Philippines.

1073 Pale brown, with three tubercles an the back. Bay of Alexandria.

1074 „ with only two tubercles. „

1075 Smooth, without nodules. „

1076 White. „

1077 Dark purple. „

1078 Spire decollated. „

1079 Circumcincta, A. Ad. Reeve, pl. 11, f. 71. Spire decollated. Bay of Alexandria.

1080 Spire perfect. „

1081 Spire half dissolved. „

1082 Perlata, Meusch. Reeve, pl. 11, f. 72. Philippines. =granifera, Kiener.

1083 Of a dark rufous-brown colour.

1084 With undulated punctured transverse lines.

1085 More elongated, granules smaller; is intermediate between N. perlata and N. hispida.

1086 Nodules fading on the back.

1087 Passing into the square noduled shell N. nodulosa, Marrat. Probably this latter is a deep water form of the N. perlata, Meusch.

1088 Mitralis, A. Ad. P.Z.S., 1851, p. 108. Reeve, pl. 19, f. 128. Philippines.

1089 Darker, narrower, and more elongated than the last. S. Archer, Singapore.

1090 Cinnamomea, A. Ad. P.Z.S., 1851, p. 107. Reeve, pl. 19, f. 126. Philippines.

1091 Badia, A. Ad. P.Z.S., 1851. p. 107. Reeve, pl. 19, f. 124. Philippines.

1092 Narrow and elongated, columella distinctly plicated; allied to the N. velata, Gould. Philippines.

1093 Short, ribbed longitudinally, intermediate between N. badia and planicostata, A. Ad.

1094 Compta, A. Ad. P.Z.S., 1851, p. 107. Reeve, pl. 16, f. 106. Cape St. Antonio, Africa.

1095 Obsoleta, Say. Gould's Inv. Massac., p. 363, f. 631. =olivæformis, Kiener. N. America.

1096 Melanoides, Reeve, pl. 22, f. 150. Moreton Bay, Australia.

1097 Succincta, A. Ad. P.Z.S., 1851, p. 107. Reeve, pl. 12, f. 80. Philippines.

1098 Drab, bands pale. G. B. Sowerby, Jun. Mouth of the Indus.

1099 Shell smaller and paler in colour, passing into the N. pallidula, A. Ad.

1100 Shell smaller and cancellated, showing a close affinity to the N. pulcherrima, Marr. Taylor Collection. Belcher, Malacca.

1101 Shell smaller and longitudinally grooved. „

1102 Semiplicata, A. Ad. P.Z.S., 1851, p. 107. Chusan.

1103 Pallidula, A. Ad. P.Z.S., 1851, p. 107, 8. Malacca.

1104 Passing into the N. planicostata, A. Ad.

1105 Quercina, Marr. (See description.)

1106 Flava, Marr. Pamphlet, p. 6.

1107 Corniculum, Olivi. Zool. Adriat., p. 144. Mediterranean.

1108 Costate.

1109 Semi-costate.

1110 Very broad, shell twice the ordinary size.

1111 Narrow and elongated.

1112 Pale red-brown.

1113 Dark brown.

1114 Pale yellow.

1115 Interior of the lip strongly toothed.

1116 „ „ almost plain.

1116A „ „ smooth.

1117 Pale reddish, banded with brown; N. fasciolata, Lam. Vol. 10, p. 172.

1118 Polished and banded, Kiener, pl. 17, f. 62.

1119 Smooth, whorls tumid, mouth pale pink.

1120 Olive, spotted with white, operculum serrated.

1121 Very closely lined longitudinally, aperture of a bright purple colour. A beautiful shell.

1122 Shell small and narrow, passing into the N. pupinoides, Reeve.

1123 Similar to the last, aperture of a dark smoke-brown colour.

1124 Stimpsoniana, C. B. Ad. Panama Shells, p. 72. Reeve, pl. 21, f. 143. Panama.

1125 Intermediate between the narrow forms of N. antillarum, Phil., and N. exilis, Powis. This shell agrees tolerably well with the N. Stimpsoniana, Reeve, as per C. B. Ad. as described by Reeve, but not with the figure; it is a much more angular shell.

1126 Combining the characters of N. festiva, Powis, and N. fasciata, Lam. Red Sea.

1127 Festiva, Powis. P.Z.S., 1835, p. 95. Reeve, pl. 18, f. 117 =lirata, D'k'r. Japan.

1128 Nodosa, Marr. (See description.) Belcher, Malacca.

1129 Mendica, Gould. Coloured variety. Oregon.

1130 Dealbata, A. Ad. P.Z.S., 1851, p. 112. Reeve, pl. 16, f. 105. Philippines.

1131 Nodata, Hinds. "Voy. of the Sulph.," pl. 9, f. 14, 15. Straits of Malacca.

1132 Acutangula, Marr. Pamphlet, p. 9.

1133 Cooperi, Forbes. P.Z.S., 1851, pl. 11, f. 4. Sandwich Is.

1134 Cooperi of American conchologists. St. Diego.

1135 „ of Marrat's pamphlet, pl. 1, f. 13. California.

1136 Onerata, Desh. Marrat's pamphlet, pl. 1, f. 28. Pacific Is.
=obliquata, Pease.

1137 Kraussiana, D'k'r. Zeit. f. Malak., 1846, p. 111. Reeve, pl. 23, f. 154. Natal Coast.
=arbiculata, A. Ad.

1138 Neritea, Linn. (Neritula, Plancus.) Reeve, pl. 23, f. 153. Mediterranean.

1139 Dark purple. Bay of Alexandria.

1140 Beautifully marked with wavy brown lines. Mediterranean.

1141 Pellucida, Risso. Reeve, pl. 23, f. 151. „

1142 Donoviana, Risso. „

1143 Kamiesch, Chenu. Man. de Conch., p. 165, vol. 1, f. 792-4. China.

1144 Insignis, Ad.
=italica, Issel.
=unifasciata, Risso.

1145 Lucida, Ad. and Angas. P.Z.S., 1864. Coodjee Bay, N.S.W.

1146 Anomalum, C. B. Ad. (Teinostoma, H. and A. Ad.)

1147 Politum, A. Ad.

1148 Abbreviata, Chem. (Desmoulea, Gray). Reeve, pl. 29, f. 194. Operculum sub-triangular, plain. Port Elizabeth, Africa.

1149 Tryoni, Crosse. Jour. de Conch., vol. 19. A variety of the last.

1150 Pinguis, A. Ad. P.Z.S., 1851, p. 113. Reeve, pl. 29, f. 193. Operculum slightly serrated. A. Ad., Senegal (?).

1151 Ponderosa, Reeve, pl. 29, f. 196. Japan.
=crassa, A. Ad. Name pre-occupied.

1152 Obtusa, Chem., p. 3489. Reeve, pl. 29, f. 195.
=retusa, Lam. Port Elizabeth, Africa.

1153 Japonica, A. Ad. P.Z.S., 1851, p. 113. Reeve, pl. 29, f. 192. Japan.

N. GLANS, LINN., AND N. PAPILLOSA, LINN.

The general resemblance between these two shells is greater than may be observed in smooth and reticulated varieties of the same shell. They have in common spiny lips, a red-brown blotch on the back, a columella and grooving of the interior, and

an apex of a reddish tint. In form they are found to resemble each other in many of the varieties, the principal distinctions being the red lines surrounding the N. glans, which are altogether wanting in any specimen of N. papillosa I have seen. At the same time it must be remembered that we have varieties of the former shell without a trace of the red lines.

The papillæ are for the most part in longitudinal series, and appear as protuberances on the ribs, very similar to the shells of N. subspinosa, Lam. A small white or yellowish shell before me, with a rufous stain on the back, coronated at the sutures, and with the ribs very irregular, is so like the N. papillosa in form, texture, colour, and striation, as to render the opinion of its being anything but a variety of that shell next to impossible.

The difficulty in understanding how it is possible for these two shells—apparently so different in external appearance, the one being smooth and the other strongly papillose—to be varieties of each other arises from the want of a little careful comparison. The following diagram will show how they unite in the first shell, to which the slightest pretension to specific distinction can be applied, viz., N. hirta, Kien. There is no break in either of the lines of the descent, therefore the line of separation appears to be open at the top of the triangle. Over this we have placed N. reticosa, J. Sow., from the Crag, one of the oldest and most variable shells in the whole genus Nassa. My reasons for placing the alliances in this order is very simple. The Nassa gemmulata, Lam., shows a change from the ribbed and cross-grooved shell, having the external sculpture very similar to the shell in question completely changed into a variety with round papillæ. Supposing that the two shells, the smooth and the papillose, have sprung from the old N. reticosa, J. Sow., then we might expect to find the papillæ to have been developed in the squares of the reticulated varieties, similar to that which has taken place in the case of N. gemmulata, Lam. There is not the slightest reason to suppose that because we find the coronation, ribs, and general sculpture developing from the smooth form that we should not also find instances in which the exactly opposite development, viz., from the sculptured to the plain, takes place.

There are many shells in this genus which present greater changes throughout their series of varieties than we find to have taken place between N. glans and all its varieties occurring in series to N. papillosa.

N. glans, Linn.	N. reticosa, J. Sow., and vars.	1154 N. papillosa, Linn.
Variety intermedia, Dunker.		1155 Var. in rib-like rows.
Var. suturalis, Lam.		1156 Var. seminodosa, A. Ad.
Var. strongly coronated, as large as the figure of glans in Reeve, pl. 1, f. 5.		1157 Var. smooth, glossy, papillæ slightly raised.
Var. upper whorls costate, suture as in glans, but coronated.		1158 Var. colour rufous brown, apex pink.
Var. granules at the suture numerous, irregular in size, all the whorls more or less costate.		1159 Var. an elongated form intermediate between N. hirta and seminodosa.
Var. strongly ribbed and coronated.		1160 Var. coronated at the sutures, slightly ribbed at the back, smooth and shining in front, passing into N. glans.
Var. uniting N. hirta and suturalis.		1161 Var. papillæ becoming obsolete.
Var. hirta, almost smooth.		1162 Var. hirta, elongated, ribs somewhat granular.
	N. hirta, Kien.	

ADDENDA.

1163 Interstincta, Marr. Quart. Jour. of Conch. A long Terebra-like shell, allied to the N. polita, Marr.

1164 Arcularia, Linn., var. sulcifera, A. Ad. Reeve, pl. 4, f. 24 (deformed). Algoa Bay, Africa.

1164A A shell connecting the N. gaudiosa, Hinds var. (Reeve, pl. 13, f. 85) with the N. limata, Chem.

1165 A shell connecting the N. gaudiosa with dark var. of N. monile, Kien.

1166 Elongated, dark mottled variety of N. gaudiosa, Hinds. Sandwich Islands.

1167 Thin, almost hyaline shells.

1168 N. gaudiosa, Hinds, passing into N. mucronata, A. Ad.

1169 „ „ „ N. picta, D'k'r.

1170 „ „ „ N. glans, Linn.

1171 „ „ „ N. punctata, A. Ad.

1172 Picta, D'k'r., closely beaded at the sutures.

1173 Mucronata, A. Ad. All but the body-whorl ribbed and cross-grooved.

1174 Between the last and N. obesa, Neville.

1175 Spirata, A. Ad., coronated.

1176 Muricata, Reeve, pl. 14, f. 73; is a pale N. spinosa, Lam. Columella smooth.

1177 Muricata, Kien., pl. 27, f. 110; is another variety of the same shell. Columella smooth.

1178 Rufula, Reeve, passing into N. glans, Linn.

1179 Nodifera, Powis, var. levukana, Watson. "Challenger" Expedition. Levuka.

1180 Allied to the last, ribs few and distant, strongly variced. Filby, China.

1181 Between the last and N. stolata, Gmel.

1182 Kieneri, Anton. The penult-whorl has been injured, throwing the upper whorls to one side.

1183 Picta, D'k'r., columella strongly plicate.

1184 „ upper whorls costate, sutures coronated.

1185 „ oblique, apex purple, resembling N. mucronata, A. Ad.

1186 Picta, D'k'r., grooved below the sutures and at the base.

1187 Between N. velata, Gould, and narrow forms of N. mucronata, A. Ad.

1188 Lævigata, Marr., with the upper whorls and part of the body-whorl ribbed, showing a passage into varieties of N. sequijorensis and ravida, A. Ad.

1189 Coronata, Brug., var. white, lip spiny; is the N. Bronni. Phil. Abbild., pl. 1, f. 17. Java.

1190 Coronata, Brug., passing into the light grey varieties of the N. nodifera, Powis, and the N. marginulata, Lam.

1191 Coronata, Brug., with the nodules divided, forming two short riblets.

1192 Coronata, Brug., semicostate.

1193 Arcularia, Linn., having the first four nodules large and all the rest small and corded.

1194 Arcularia, Linn., having all the upper whorls closely cancellated and the body smooth and polished.

1195 Nodifera, Powis, passing into the N. stolata, Gmel.

1196 Picta, with the internal lyrellæ interrupted and displaced.

1197 Livescens, Phil., has the spire inclining towards the aperture (deformed).

1198 Livescens, Phil., has the spire inclining towards the back of the shell (deformed).

1199 Livescens, Phil., callous broad, covering the front of the shell.

1200 Livescens, Phil., a large, elongated shell with a double lip. Philippines.

1201 Livescens, Phil., with a thick piece of shelly matter cemented on to the base of the lip, a very clumsy affair.

1202 N. glans, Linn., var. suturalis, longitudinally flamed and spotted, passing into the N. marmorata, Anton.

1202A Incrassata, Müll., so like the N. ambigua, Montg., as to make it difficult to distinguish the West Indian from the Mediterranean shell. Is it probable that Montague could have obtained a variety similar to this on the British coast?

1203 Incrassata, Müll., var. glaberrima, having a kind of mosaic or tessellated sculpture.

1204 Incrassata, Müll., var., glaberrima, transversely punctato-striate. Malta.

1205 Incrassata, Müll., var. gibberula, Marr. (Taylor Collection.) Mediterranean.

1206 Incrassata, Müll., var. varicosa, Turt., small, whorls somewhat angular, without varices. Malta.

1207 Incrassata, Müll., passing into the N. luctuosa, A. Ad., striated transversely.

1208 Incrassata, Müll., with the tip of the spire yellow.

1209 Between N. capensis, D'k'r. and N. signata, D'k'r.

1210 „ „ „ and N. serotina, A. Ad.

1211 „ „ „ and N. tenella, Reeve.

1212 „ „ „ and N. terebroides, Reeve.

1213 „ N. serotina, A. Ad., and N. incrassata, Müll.

1214 „ N. signata, D'k'r., and „ „

1215 „ N. tenella, Reeve, and „ „

1216 „ N. terebroides, Reeve, and N. labiata, A. Ad.

1217 „ N. serotina, A. Ad., and N. signata, D'k'r.

1218 „ N. distorta, A. Ad., and N. monile. Kien.

1219 „ N. lachrymosa, Reeve, and N. monile, Kien.

1220 „ N. prompta, Marr., and N. fida, Reeve.

1221 „ N. incrassata, Marr., and N. plebecula, Gould.

1221A „ „ „ and N. argentea, Marr.

1222 „ N. babylonica, Watson, „ „

1223 Marmorea, A. Ad., described as two-banded by A. Adams. P.Z.S., 1851, p. 106.

1224 Marmorea, A. Ad., described by Reeve, at p. 2, species 7, as three-banded.

1225 Marmorea, A. Ad., marbled, but without bands.

1226 Between N. marmorata, Anton, and N. marmorea, A. Ad.

1227 „ „ „ and N. mutabilis, Linn.

1228 „ „ „ and N. glans, Linn., slender forms.

1229 Gibbosula, Linn., spire incurved (deformed). Alexandria.

1230 „ banded with short, transverse, dark-brown lines, particularly in young shells.

1231 „ var. circumcincta, A. Ad., decollated.

1232 „ „ with the spire perfect.

1233 Plebecula, Gould, a narrow transparent form, passing into the varieties of N. clathratula, A. Ad.

1234 Cinctella, Gould, a narrow transparent form, passing into the varieties of N. clathratula, A. Ad. Viti Islands.

1235 Paupera, Gould, scabrous variety. Japan.
=samoensis, D'k'r.
=balteata, Pease.

1236 Paupera, Gould, var. tasmanica. Tasmania.

1237 Burchardi, D'k'r., broad variety. =labecula, A. Ad.

1238 Labiosa, J. Sow. Crag. Var. maculata, A. Ad. Small and narrow. Philippines.

1239 Marginulata, Lam., dark brown, with a white central band. S. Archer, Singapore.

1240 „ ribs distant, interstices grooved. Canton.

1241 Tænia, Gmel., small, dark brown, with a central white band. New Guinea.

1242 „ smooth, highly polished.

1243 Plicata, Meusch. (?), passing into the N. venusta, D'k'r. Ceylon.
=thersites, Brug.

1244 Tabescens, Marr. (See description.)

1245 Compta, A. Ad., passing into the N. succincta, A. Ad. var.

1246 „ „ N. velata, Gould.

1247 „ „ N. pallidula, A. Ad.

1248 Bimaculosa, A. Ad., a small oblique form. Singapore.

1249 „ var. immersa, Carpt., variety elongated.

1250 Sesarma, Marr., all the whorls, with the exception of the two last, ribbed and coronated.

1251 Jacksoniana, Quoy and Gaim., passing into N. subspinosa, Lam. S. Archer, Singapore.

1252 Between N. undata and sesarma, Marr.

1253 Callospira, A. Ad., ribs plain.

1254 „ ribs cross-grooved.

1255 „ ribs granular.

1256 Semigranosa, D'k'r. The thick white granular varieties pass into the white varieties of the N. nodicinata, A. Ad.

1257 Between N. sertula, A. Ad., and N. polita, Marr.

1258 „ N. polita and interstincta, Marr.

1259 „ „ and bucculenta, Marr.

1260 „ N. bucculenta, Marr., and corniculum, Olivi.

1261 Tænie, Gmel., smooth, polished, and pale in colour. New Guinea.

1262 Marginulata, Mart. and Chem., 2nd edit., pl. 12, f. 7, 8, is intermediate between the shell of Lam. and the next.

1263 Sordida, A. Ad., callous very thick and spreading.

1264 Reticulata, Linn., from the coast of Norway. Zool. Record.

1265 „ var. 1., cancellata, Chem.

1266 „ var. 2., paucicostata. =nitida, Jeff.

1267 „ var. 3., paupercula, with thick epidermis.

1268 Reticulata, Linn., a large oblong variety with broad varices, covered with a brown epidermis. Shell 1½ inches long. Mediterranean.

1269 Reticulata, Linn., very like the N. plicosa, D'k'r., both in form and colour.

1270 Reticulata, Linn., lirellæ on the inner lip broken and interrupted.

1271 Reticulata, Linn., tapering to a very fine point, distorted.

1272 Reticulata, Linn., closely allied both in form and sculpture to the N. gemmulata, Lam.

1273 Reticulata, Linn., closely allied both in form and sculpture to the N. monile, Kien.

1274 Reticulata, Linn., closely allied both in form and sculpture to the shell mentioned at No. 452.

1275 Hanleyana, Marr. (See description.)

1276 Fossata, Gould. California.
=N. elegans, Reeve, con. syst., 1842, name pre-occupied by J. Sow., Min. Couch.
=Zaphon elegans, Reeve. A. Ad., Rec. Moll., vol. 1., p. 121.
=Tritia fossata, Gould. „ „ „ p. 122.
=Nassa Morleti, Crosse Jour. de Conch., vol. 16, 1868, pl. 6, f. 3.

1277 Columella and lip deep orange.

1278 Body-whorl semicostate, with strong transverse granular lines.

1279 A small N. grata, Marr., narrow, with the centre of the lip thickened, like a columbella. Siam.

1280 Between N. mendica, Gould, and N. festiva, Powis. Oregon.

1281 „ N. sinusigera and costata, A. Ad.

1282 „ „ and pauperata, Lam.

1283 Gibbosula, Linn., bored through the thickest part of the callous.

1284 „ with a pale-brown epidermis.

1285 „ with the hump on the left hand side of the shell, instead of on the right.

1286 A shell uniting the N. vibex and acuta, Say, and N. tiarula, Kien.

1287 Cooperi, Forbes var. Marrat's pamphlet, pl. 1, f. 13. California.

1288 Between the last and antillarum, Phil. Honduras.

1289 Sinarum, Phil. var. North China.

1290 Nodata, Hinds var., interior with two brown bands. Canton.

1291 Muricata, Quoy and Gaim, with the whole callous granular and plicate. Ceylon.

1292 Bimaculosa, A. Ad., with the hump on different parts of the back of the shell.

1293 Bimaculosa, A. Ad., passing into varieties of N. thersites, Brug.

1294 „ „ „ of N. leptospira, A. Ad., and N. foveolata, D'k'r.

1295 Between N. striata, Reeve, and N. paucicostata, Marr.

1296 „ N. pura, Marr., and N. ambigua, Montg.

1297 „ N. delicatula, A. Ad., and „

1298 Corrugata, Taylor Collection. A thin Columbella-like shell, with oblique ribs. California.

1299 Corrugata, var. broader, spotted with red-brown.

1300 „ var. elongated, scabrous.

1301 Acuta, Say, passing into the small form of N. sturmii, Phil.

1302 A variety of N. concinna, Powis, with the whorls rounded, causing a depression at the sutures.

1303 Another in which all the whorls, with the exception of the body-whorl and half of the penult, are white; here an injury has taken place, and the last turn and a half are banded.

1304 Another, very narrow, passing into the N. Smithii, Marr.

1305 „ with the beaded line at the sutures, deformed.

1306 Between N. concinna, Powis, and N. japonica, A. Ad.

1307 Cærulea, Marr. (See description.)

1308 Plebecula, Gould, large and thin, passing into the N. japonica, A. Ad.

1309 Plicosa, D'k'r., passing into the N. pallida, Powis.

1310 Marmorata, Anton, „ N. graphitera, Beck.

1311 Undata, Marr., „ N. Asperula, Brocchi.

1312 Elegans, Kien., „ N. lævigata, Marr.

1313 Canaliculata, Lam., „ „

1314 Hirta, Kien., „ N. monile, Kien.

1315 Algida, Reeve, „ N. marmorata, Anton.

1316 Algida, Reeve, passing into the N. lævigata, Marr.

1317 Kieneri, Anton, „ „

1318 Nodifera, Powis. „ N. hirta, Kien.

1319 „ „ N. monile, Kien.

1320 Marginulata, Lam., small forms, passing into the N. planicostata, A. Ad.

1321 Limata, Chem., passing into the N. undata, Marr.

DESCRIPTIONS.

WHAT are the shells described in the following pages?

My answer to this question is, I do not know.

The amount of knowledge is confined to the single specimens in most instances, and to three or four at most, in any case. These may be isolated individuals, or they may exist in thousands in certain localities not yet explored. At present these shells appear to me to be distinct, simply because of my ignorance of all their alliances, but that this should be the real state of the case is exceedingly improbable, if not absolutely impossible. That future conchologists will be found to follow any rules I may think proper to dictate to them, is neither my wish nor my intention; if they do not act upon their own independent judgment they will not make much progress.

1128 N. nodosa, Marrat.—Shell somewhat turreted, sutures deeply grooved, whorls rounded, very strongly noduled, nodules large in the centre of the whorls and tapering towards each end, those on the last whorl representing a bi-tubercular keel; ribs white, with rather dark bluish-grey broad belts in the interstices; the first four or five whorls of the apex are yellow, aperture sub-oval, columella with two broad folds, interior brown, with a white central band. Belcher, Malacca.

45 N. prompta, Marrat.—Shell ovately conical, highly polished, pale yellowish white, with two reddish-purple dotted bands, one in the centre of the body-whorl, the other near the canal at the base, whorls rather flattened, ribbed to the base in

front and not more than half-way down behind, raised into blunt nodules at the sutures, aperture semi-lunate, columella thickened but not spreading, tubercular, outer lip very thick, with a thin edge near the aperture; throat with rather strong and somewhat distant ridges, canal very short, stained on each side of the base with brown.

This may be only a variety of that interminable shell, N. incrassata, Müll., but I have not seen any varieties that are likely to connect them.

854 N. picturata, Marrat.—Shell ovately-conical, glossy, rather broad at the base, white, with numerous transverse brown bands, the central one being the most distinct, apex purple, whorls rounded, somewhat angular below the sutures, strongly ribbed longitudinally and closely grooved transversely, sutures only represented by a fine line, the penult-whorl is angularly noduled, aperture oval, columella defined, plicate, outer lip thick, within plicate.

This may be only a large variety of N. versicolor, C. B. Adams. The nearest shell figured is one in Kiener, at plate 21, figure 81, under the title of N. ambigua, Montague. Our shell is twice as large as Kiener's figure.

N. acuminata, Marrat.—Shell acuminately-oblong, of a pale ash-brown colour, banded with pale brown, whorls obliquely rounded, grooved near the base of the last whorl, strongly coronated at the sutures, sutures canaliculate, the six or seven upper whorls strongly ribbed, the penult semicostate, aperture oval, columella with a thin spreading callous, outer lip thickened, thin on the edge and spiny at the base, throat plicate.

An intermediate form connecting the smooth shells of N. trifasciata, Gmel., with the N. scalaris, A. Ad.

Obs.—Another shell is quite smooth and shows the passage into N. trifasciata, Gmel., on the one hand, into the N. scalaris, A. Ad., on the other.

N. ferruginea, Marrat.—About three-quarters of an inch long; it is similar in form to some of the smaller varieties of N.

punctata, A. Ad., but is less acuminated; the colour is white, flamed and marbled with orange, transversely lined; there are three or four folds behind the thickened lip, sutures finely plicated. This is an interesting shell; it shows a passage from such shells as the N. lentiginosa and punctata, A. Ad., &c., into N. glans, Linn.

452 N. lyræformis, Marrat.—Shell ovate, ventricose, longitudinally ribbed, ribs curved, transversely grooved, one-third of the body-whorl from the base closely granular, pale, with two broad olive-green bands, granules white, sutures coronated, with a groove-line just below the beads, columella spreading, with the ribs protruding through the thin callous, throat brown with a white band, closely plicate. China.

Obs.—While the form of this shell is that of N. gemmulata, Lam., the colour and texture resembles that of N. marginulata, Lam., and N. nodifera, Powis; the sculpture also shows this intermediate character.

389 N. bucculenta, Marrat.—Shell somewhat acuminately-ovate, of a pale chocolate brown colour, banded and longitudinally striped with darker tints of a similar colour, whorls ventricose, smooth, the upper whorls strongly costate, the body-whorl deeply grooved at the base, sutures either closed or canaliculate, aperture oblong-ovate, columella plicate at the base, the callous clearly defined, not spreading; the outer lip is thickened, with two or three folds behind it, thin at the edge and slightly coronated, throat closely plicated. Philippines.

Obs.—There appears to be a union of several supposed distinct species in this shell. In the first place it resembles the N. elegans, Kiener, in its broad form; in the next place it can be associated with certain varieties of the N. glans, Linn; in small specimens again, some of the shells are thick and narrow, approaching some of the forms of N. compta, A. Ad.; and lastly, the square markings closely resemble those on the N. algida, A. Ad.

47 N. polita, Marrat.—Shell elongately-conical, polished, of a brownish-ash colour, with pale bands a little darker than the

ground-colour of the shell, apex dark in some of the specimens, whorls somewhat rounded, smooth, granularly costate near the apex and deeply grooved at the base of the body-whorl, outer lip very thick, inner lip smooth in some of the specimens and lyrate in others, columella circumscribed, mostly smooth. Mauritius.

Obs.—An elongated shell, allied to the last as well as to N. compta, succincta and pallidula, A. Ad.

1105 N. quercina, Marrat.—Shell somewhat acuminately-ovate, thick, ash-grey, marbled with fainter tints, whorls rounded, smooth, with the exception of the upper whorls of the spire which are costate, as is usual in almost every Nassa, columella smooth, curved, callous very thick, considerably expanded below, and continued up the body-whorl nearly to the sutural canal; outer lip thickened, forming a blunt edge to the border of the aperture, inner lip strongly plicate.

Obs.—This is nearly allied to that very variable shell, N. corniculum, Olivi, and may be only a variety of it.

778 N. granulosa, Marrat.—Shell elongately-conical, spire acuminated, pale buff, variegated with reddish brown, whorls convex, longitudinally ribbed and transversely grooved, granulated, with a beaded necklace below the sutures, aperture oval, columella plicate, inner lip strongly lyrate, thin on the edge.

Obs.—This shell clearly illustrates the tendency of all these forms to begin with the broadest and gradually to narrow into the most narrow and elongated varieties. I have a good series of the different varieties of form of the N. splendidula, Dunker, but this is far more bulimoid than any of the slender forms of that shell.

768 N. lactea, Marrat.—Shell ovately-conical, white, apex pale purple, whorls rounded, costate throughout, ribs smooth, interstices closely grooved, coronated at the sutures, grooved below the beads, one of the ribs has a second bead below the first or sutural one.

Obs.—Resembling the N. cælata, A. Ad., and the N. rugosa, Marr.; it also shows an affinity with the N. fasciata, Lam., and the N. trivittata, Say.

N. decorata, Marrat.—Shell ovately-conical, whorls convex, longitudinally ribbed and strongly noduled, white, banded with brown, sutures somewhat canaliculated, aperture oval, columella wrinkled, outer lip thick, white, interior plicate, the last whorl angular at the base.

Obs.—These very small shells may prove to be a variety of some other species; but if so, they have taken a very peculiar and abnormal form.

571 N. grata, Marrat.—Shell ovately-conical, greyish-ash banded with brown, whorls rounded, strongly ribbed, interstices closely and deeply grooved, sutures noduled, the first forming the thickened lip large, aperture oval, columella thin, a little expanded, warty, outer lip thick, white, inner lip in some of the specimens almost smooth, in others with few and distant strong folds, crenated, toothed at the base. Canton.

Obs.—I have no doubt that this shell will prove to be one of the connecting links between N. marginulata, Lam., and the N. Wilsoni, Reeve (not C. B. Adams.) Another variety, twice the size of the shells described, has been shown to me by Mr. Archer, it is from the Gulf of Siam.

1307 N. cærulea, Marrat.—Shell ovately-elongated, greyish-ash, banded with blue, polished, whorls rounded, longitudinally finely striated, sutures closed, aperture oval, columella strongly wrinkled, callous thickened, somewhat spreading, outer lip thick, interior toothed.

Obs.—This shell, which is about the size and nearly the colour of N. glabrata, A. Ad., is not distantly related to the N. trifasciata, Gmel.; it is also closely allied to the N. planicostata, A. Ad., and to some of the varieties of N. corniculum, Olivi; operculum crenated.

1244 N. tabescens, Marrat.—Shell ovately-conical, white, banded with brown, whorls rounded, strongly ribbed, ribs smooth, interstices closely grooved; the body-whorl has the ribs close and numerous, the penult-whorl has not more than half as many, the third has very few; this may arise from some defect in the animal; aperture oval, columella plicate, callous thin, outer lip thick, grooved.

Obs.—This small shell is allied to the N. marginulata, Lam., and also to the N. fraudulenta, Marr.

775 N. pusilla, Marrat.—A N. sequijorensis, A. Ad., in miniature. Shell ovately-turreted, pale reddish-brown, banded with darker colour, the upper whorls and behind the lip costate, the last whorl finely striated longitudinally, grooved near the base, almost smooth in the middle, aperture oval, columella slightly wrinkled, outer lip thick, prickly denticulated on the edge. S. Archer, Singapore.

1125 N. lauta, Marrat.—Shell acuminately-conical, of a greyish lead colour, with a few interrupted reddish-brown transverse lines, whorls angular, with prominent nodules at the angles, transversely ridged and finely striated, strongly ribbed, ribs distant, apical whorls translucent, aperture angular, outer lip thickened, toothed on the inside, columella thin, plicate. Belcher, Malacca.

Another variety has white bands, and the red-brown lines are replaced by white ones. Belcher, Malacca.

Obs.—These are intermediate between the N. stimpsoniana, C. B. Ad., and N. exilis, Powis.

554. N. crassicostata, Marrat.—(Not the Pamphlet, p. 6.) Shell ovately-conical, pale drab, waxy, with two leaden bands, one near the middle of the body-whorl, the other in dots in the interstices near the sutures, whorls convex, strongly ribbed, very thick behind the lip, aperture somewhat oval, columella smooth in two and wrinkled in other two varieties, outer lip very thick, inside plicate. Bombay.

Obs.—Between the short, broad forms of N. nodifera, Powis, and the N. costata, A. Ad.

972 N. quinquecostata, Marrat.—Shell ovately-turreted, white, apical-whorls flesh coloured, whorls rounded, somewhat angular below the sutures, body-whorl with five prominent ribs, with one, sometimes two, smaller intermediate ones between them, interstices finely striated, aperture semi-ovate, columella smooth with two oblong folds at the base, outer lip thickened, interior plicate. This shell would be thought

to be a very distinct species by most conchologists, but having a very fine series of its allies, I am enabled to trace it into broader and well-known forms. The shells of this group are extremely variable in both form and in the number of their ribs. N. ambigüa, Montg., N. annellifera, Reeve, N. obtusata and clathratula, A. Ad., N. rotundicostata and paucicostata, Marr., are all varieties of one shell, and *this is another variety.*

869 N. sculpta, Marrat.—Shell ovately-fusiform, white, banded with pale rufous, whorls rounded, longitudinally ribbed and transversely grooved, slightly coronated at the sutures, aperture obliquely oval, columella smooth, with a single fold at the base, callous somewhat spreading, white, outer lip thickened, with a thin edge, interior plicate. S. Archer, Natal.

Obs.—This is an interesting shell, showing a passage from the smooth N. compta, A. Ad., to the N. propinqua, J. Sow., N. splendidula, D'k'r., and the N. marginulata, Lam., small varieties, without the thickened callous.

1275 N. Hanleyana, Marrat.—Shell ovately-globose, white, with pale indistinct yellow bands, whorls round, longitudinally costate and transversely grooved, all but the body-whorl strongly granular, aperture oval, columella plicate in one, almost smooth in another, callous somewhat spreading, outer lip very thick, inside closely plicate.

Obs.—So completely does this shell show the union between the papillose shells, such as the N. gemmulata, Lam., var. verrucosa, A. Ad., N. splendidula, D'k'r., &c., with such shells as the N. ambigua, Montg., N. annellifera, Reeve, and the N. obtusata, A. Ad., &c., as to leave no doubt about the one being a continuation of the other, in a direct line of descent.

793 N. Parva, Marrat.—Shell ovately-conical, white, lined and banded with dark brown, longitudinally ribbed and transversely striated, ribs few and distant, somewhat knotted, aperture ovate, columella plicate, callous defined, outer lip thick, inner edge denticulated, apex of the spire dark purple.

GENERIC ALLIANCES.

LAMARCK separated the genus Nassa from the parent Buccinum, Linn., in 1792. "This genus is not admitted by all conchologists as a necessary separation from the Linnæan genus Buccinum, and, in fact, Lamarck subsequently re-united them, without assigning any reason for so doing."—S. Wood's "Mollusca from the Crag," vol. 1, p. 28.

In the Nassa reticosa, J. Sow., variety rugosa, we have a shell possessing the characters of Buccinum. Several of the Nassæ are simply small forms of their large parents; the N. pyramidalis, A. Ad., is a small form of Buccinum undatum, Linn., var. glaciale; N. undata, Marr., was so named in consequence of its resemblance to B. undatum, and many other representative forms might be given by way of illustrating the alliances of the two supposed genera.

The Desmoulea abbreviata, Chem., is very nearly allied to the Nassa pupa and N. conglobata, Broc., both of which pass by means of N. obliquata, Broc., into N. mutabilis, Linn. One of the most variable shells in the Buccinum group is the Phos senticosus, Linn.; the broad and short forms are closely allied to some of the shells in the genus Nassa. In the animal of Phos one of the principal differences pointed out is the foot tapering into a filament—not a very satisfactory character, I must say, after the statement with regard to the same part of the animal of Nassa being bifid. Another shell, figured in D'Orbigny's "Cuba" under the name of Cancellaria candei, D'Orb., is an intermediate form between Nassa and Phos. The Strongylocera, Morch., is a badly defined group, including such shells as the Phos textilinus, Sow., and Buccinum costatum, Quoy and Gaim., "Voy. l' Ast.," pl. 30, f. 17, 18, &c.

Bullia is closely allied to Nassa; we find a great resemblance existing between the small forms of the B. semiflammea, Reeve, and the shells placed by H. and A. Adams as Aciculina, a subdivision of the genus Nassa; the two varieties, Bullia polita, Lam., and semiplicata, Gray, are related to the N. trifasciata, Gmel., and the narrow forms of N. glans, Linn.; another shell named and figured by Reeve as the B. truncata, is much nearer the shells in the genus

Nassa than Bullia: it has a thickened lip, a plicate columella, and the inner lip is toothed. Bullia differs from Nassa in the animal having no eyes; but the parallel series of forms is so extensive as to suggest that some examples of Bullia are only eyeless forms of Nassa. Notwithstanding the fact that, as vegetable feeders, the Rissoæ have been placed at a great distance from the Nassæ in most modern arrangements, they present numerous points of resemblance; many of the shells are miniature representatives of the larger Nassæ, and the canal at the base is rudimentary in several Nassæ.

The N. rissoides, Marr., very closely borders on the genus Rissoa.

The genus Nassaria, Link, is composed of Nassæ with elongated canals, and the N. pagoda, Reeve, is an intermediate form.

The Northia serrata has so many characters in common with the elongated forms of N. trifasciata, Gmel., that it is difficult to see how they differ; they are similar in texture, in colour, in having the upper whorls cancellated, in having a thickened outer lip, and in having sharp, prickly serratures on the edge of the lip. Several shells, placed by some authors among the Strongylocera, Morch., and by H. and A. Adams in a sub-division of the Nassæ (Uzita), are intermediate in their characters between Nassa and Purpura; they consist of the N. pallida, Powis., Reeve, pl. 9, f. 30; Bucc. Gaulterianum, Kiener, plate 19, f. 70.; N. plicosa and Morrisii, Dunker, &c.; and the Purpura nassoides, Quoy. and Gaim., is a nassoid form of Purpura.

The N. varicifera and N. scalaris, A. Adams, show an affinity with the genus Scalaria, or Scala, as it is shown to be by priority.

Many of the shells placed in the genus Columbella are difficult to distinguish from this genus (Nassa). The hard and fast lines drawn tightly round certain genera are much simpler to recognize on paper than when observation is brought to bear upon them practically. I have had considerable difficulty in determining to which of the two genera some of my shells belong, and many of my conclusions regarding them have been anything but satisfactory. The two genera glide so imperceptibly into each other that it is impossible to separate them.

There are three shells belonging to different genera that appear to converge to a point. The first is the Nassa (Aciculina) vittata, A. Ad., an almost smooth form; the second is the Terebra (Euryta) aciculata, Lam., smooth varieties; and the third is a Bullia from the Cape of Good Hope, having about the same proportions as the two previously-named shells, glossy and marked with bluish spots below the sutures. We have also specimens of the Columbella Menkeana, Reeve, from Australia, closely allied to the three elongated shells above-mentioned. Clark, in his "Marine Testacea," has placed both the genus Buccinum and Nassa in the genus Murex, from the resemblance the animals have to each other. The Cyllene, Gray, is by no means distantly related to this genus (Nassa), the N. crassicostata, Marr., and the C. lyrata, Lam., are similar in colour, texture, ribbing, columella and thickened outer lip, the narrower and oblique form is all in which they differ. Planaxis is represented by a small shell described by Garrett under the name of N. anthracina, "Proc. Acad. Nat. Sci., Philad., 1873." The Cominella (Buccinum) nassoides, Reeve, as its name implies, is closely related to the shells in this genus. Another genus, formerly included in Buccinum, the Truncaria, A. Ad. and Reeve, consists of shells allied to some of the varieties of Nassæ. The N. varicifera, A. Ad., in its mature state, resembles both in cancellation and the varices shells in the sub-genus Rimella in Gladius=Rostellaria. N. tritoniformis, Kiener, is allied to the Nassaria suturalis, A. Ad., Singapore.

An Illustration of one of the Lines of Descent.

The varieties of the following shells meet at so many points, and intersect each other in such a variety of ways, that it appears to me quite useless to attempt to separate them into species.

The fifty shells to which names have been given do not represent a quarter of the forms in my cabinet, nor could any conchologist determine the relationship existing between these specimens without first having seen the numerous unnamed and unfigured varieties by which they are connected. Very few

persons have seen a shell of the Nassa incrassata, Müller, at least twice as broad, and with a much more expanded lip, than the large variety figured in Reeve's "Conchologia Iconica," notwithstanding there are such shells and many other curious forms equally unknown to conchologists. It is such varieties as the specimens just mentioned that have enabled me to unite so many of the spurious species.

At least two hundred examples of these shells are in the trays before me, and the diverging forms appear to be very numerous among them.

Some of the names given in this list are only synonymes, others are known to be varieties, and have been generally recognised as such by conchologists. There is not a group, nor scarcely a shell in any of the groups, that one or other of the varieties of Nassa incrassata, Müller, does not approach rather closely, and the intermediate forms between it and other named shells are very numerous. A recent shell is so like the fossil N. asperula, Brocchi, that it is a difficult matter to determine in what respect they differ the one from the other.

The most appropriate name for this shell is that applied to it by Philippi, viz., Nassa variabilis, for a more variable shell is not to be found either in this or any other genus in the whole category of shells.

We have given this example as an illustration of one of the lines of descent, but not necessarily terminated at either end, neither do we profess to give the varieties in their consecutive order.

There are two other groups closely allied to this, and several of the shells belonging to each pass from one to the other by imperceptible gradations.

One is composed of shells covered with granules or papillæ, and includes the N. gemmulata, Lam., and its variety verrucosa, A. Ad., N. granulata, Marr., &c. The shells in the other group are more or less ribbed and cross-grooved; included in this series is the N. prismatica, Brocchi, N. versicolor, C. B. Ad., N. striata, Reeve, &c.

N. tritoniformis, Kien.

Incrassata, Müll. A large form, passing into the last.

A short and broad form, large.

Beautifully cancellated.

Ribs oblique.

Passing into the variety N. glaberrima, Gmel.

These large varieties, of which there are at least twenty, pass into the medium, and thence into the small and very small forms.

The following names, for the most part, were applied to certain varieties—

N. exilis, Gmel.
Lacepedii, Payr.
Ascanias, Brug.
Macula, Mont.
Rudis, Gault.
Minuta, Penn.

Other varieties passing into the—

N. asperula, Brocchi.
Plebecula, Gould.
Multigranosa, D'k'r.
Hotessieri, D'Orb.
Ambigua, Montg., tall forms.
Striata, Reeve.
Varicosa, Turton.
Coccinella, Lam.
Rosacea, Reeve.

There are at least a dozen varieties of N. incrassata of a rose colour.

Narrow forms pass into the—

N. tenella, Reeve.
Serotina, A. Ad.
Signata, D'k'r.
Capensis, variety ribbed and cross-grooved.
Capensis, D'k'r.

The last-named shell passes into the narrow costate varieties of N. glans, Linn.

The small varieties pass into the—

N. Compacta, Angus.
Æthiopica, Marr.
Pumilio, Smith.

Small cylindrical varieties pass into the—

N. bibalteata, Pease.
Unifasciata, Pease.
Microstoma, Pease.
Fratercula, D'k'r.
Babylonica, Watson.
Dermestina, Gould.
Tringa, Souv.

Other varieties. N. scabriuscula, Powis.
Nigella, Reeve.

N. glaberrima, Gmel. I consider this to be a form of N. incrassata, Müll. Its varieties are very numerous, at least fifty are before me.

N. cuvieri and lacepedii, Payr.
Variabilis, Phil.
Tinei, Marav.
Unifasciata, Kien.
Gallandiana, Fischer.
Madorensis, Reeve.
Encaustica, Brusina.
Gemmellari, Biondi.

Intimately connected with these shells are the following, most of which are West Indian forms:—

N. paucicostata, Marr.
Quinqueplicata, Marr.
Rotundicostata, Marr.
Annellifera, Reeve.
Obtusata, A. Ad. Philippines.
Variety. West Indies.
Hanleyana, Marr.
Nucleolus, Phil.
Pura, Marr.
Versicolor, C. B. Ad.
Sanctæ Helenæ, A. Ad.
Acuta, Captr.
Crebristriata, Captr.

A specimen of the N. Sternsiana, Garrett, has just come to hand; it proves to be a variety of the N. crenolirata, A. Ad., from Singapore. The author had his doubts and sent for information.

Varieties Obtained at One Locality by a Single Haul of the Dredge.

Captain Horsfall, of the steamship "Canopus," plying between Liverpool and Alexandria, calling at Malta and Gibraltar, placed all the shells brought up from a rich spot of dredging ground in a match-box, and gave the box with its contents to me. It is labelled, "Off Malta."

There were quite a large number of rare and interesting genera almost peculiar to the Mediterranean Sea, such as Typhis Sowerbyi, Broderip; Murex cristatus, Brocchi, var. Blainvillei; Raphitoma gracilis and linearis, Montague, costata, Donovan, and var. coarctata; Erato lævis, Donovan; Marginella (Gibberula) clandestina, Brong., and miliaria, Linn., &c. Among the bivalves were Kellia suborbicularis, Montg.; Woodia digitaria, Linn.; Mytilicardia aculeata, Poli, &c. There were also two or three different species of Brachiopods, among them Crania, Rostrata, Hœn, &c. The most interesting, as well as the most curious part of the collection obtained, however, is a series of varieties belonging to the genus Nassa, illustrating a phase in the history of these shells totally at variance with all my previously conceived ideas regarding the distribution of what are termed species and varieties. I had obtained a fine series of varieties of the Nassa incrassata, Müller, as well as a numerous collection of its variety, Nassa glaberrima, Chemnitz, from the different stations at which the most distinct forms had been collected, the impression existing in my mind being that the changes that had taken place in these varieties had been produced by local variation, such as temperature, food, &c., but when the varieties were obtained, as in the above instance, by Captain Horsfall, upon the same bank and in the same water, no such governing influences could have been instrumental in producing them. The first is a narrow variety of the N. prismatica, Brocchi, with oblique ribs, showing an affinity with the N. miga, Adamson, from Senegal. So many of the Mediterranean Shells are represented by African forms that we cease to regard the circumstances as any-

thing peculiar. The second are narrow varieties of the N. reticulata, Linn.; one of these is strongly warted; the warts are translucent, like wax. The third is a beautifully-mottled and banded specimen of the N. corniculum, Olivi, with a bright purple aperture; there is also a bright-banded variety of the N. fasciolata, Lam., with a yellowish-brown mouth. Another variety has strong longitudinal ribs, with groove-like striæ at the base. The fourth is a broad form of the N. incrassata, Müll., with oblique ribs, a rough, strong shell, with small portions for the epidermis still attached to it. A tall narrow variety, with somewhat carinated whorls, deeply excavated at the sutures; another shell has round whorls, and a third has strong varices. Two other remarkable varieties of the shell known as N. varicosa, Turt., one with strong granules and somewhat angular whorls, without varices; the other specimen has the upper whorls and about one-third of the body-whorl granular, and the remaining part simply grooved; this is also without varices. Another granular variety is banded with brown, has a brown columella, and the ribs are distant from each other. The following varieties of the N. glaberrima are extremely interesting, showing such a large amount of variation in a shell that is only itself a variety. The first of these is a shell with round whorls, having a single red band in the centre of the body-whorl, similar to the N. unifasciata, Kien; the upper whorls are all costate, while the body-whorl is only slightly grooved transversely. The second is a strongly costate, small shell, showing an affinity with the N. delicata, A. Ad. Another variety of this costate shell has transverse equi-distant lines covering the whole surface of the shell. A third specimen has the ribs few and wide apart. A fourth variety is white, with strong longitudinal ribs, showing a close affinity with the N. sinusigera, A. Ad., and seems to assimilate with some of my varieties of N. costata, A. Ad. A fifth form is bright and shining, beautifully marked, with short interrupted brown lines, similar to those occurring on the young specimens of N. gibbosula, Linn. One specimen, similar to the variety figured in Reeve, pl. 19, f. 129, has been bored through the last whorl. I wonder if these fellows are cannibals. A sixth is a

dark brown, costate variety, with two pale lines on the thick brown callous of the columella. The last, although not the least interesting form, is an almost white shell, tessellated with brown, the strongly curved ribs and transverse striæ showing a close connection with the N. marginulata, Lam., and all contained in a common halfpenny match-box.

There were among them two specimens so remarkably like the N. zonalis, A. Ad., that it is very difficult to determine in what respect (with the exception of size) they differ, the ground-colour, the banding and the general outline form of the shell and rounding of the whorls are all similar in each.

SUMMARY.

I DO not wish to state that the evidence derived from a study of the Nassæ is sufficient to prove that the genus is constituted by *one shell in an endless variety of forms.* Nevertheless, the mass of evidence appears to me to point in that direction.

It is often a matter of extreme difficulty to decide whether a shell figured as distinct is not merely a deformity; such abnormal examples may be found in the N. sulcifera, A. Ad., from Algoa Bay, the N. distorta, A. Ad., and the N. stolida, A. Ad., all figured from solitary specimens. Many of the shells in my cabinet are more or less deformed varieties; two of them are quite as much deserving of being distinguished as any of those above enumerated. The first is N. picta, D'k'r., with the spire elongated in about the same proportion with that of the N. monile, Kien., variety distorta, A. Ad., and presenting as much difference from the ordinary state of the shell as that does. The other is N. coronata, Brug., with the thickened *callus* projecting and covering one-half the penult-whorl; the new piece of shelly matter forming the lip has been placed obliquely and has obliterated both the sutural canal and the nodules; a second piece is costate for about one quarter-of-an-inch; this is also a former injury, and then the shell assumes its ordinary appearance. I should as soon think of making

a hump-backed or club-footed man into a distinct species from his uninjured brothers as putting such shells as these forward as distinct species. The innumerable divergences, not only in the direction of named shells, but into others not hitherto named, were so constantly springing up, that the direct lines appeared to constitute only a portion of the total lines of divergence. It must also be borne in mind that the varieties can only extend to the centre between two supposed species.

Several of the shells appearing in the early part of this paper are treated as if they were distinct, whereas in the latter pages they are placed as varieties of other shells; this arises from the fact that the numerous comparisons which had to be made, and the extraordinary number of examples which had to be compared, produced at length sufficient evidence to induce me to unite these shells under the head of varieties.

For the last fifteen or sixteen years I have been examining the subject of variation, and in all the genera containing an extensive series of what are termed species the study has presented results very similar to those obtained from the shells in the genus Nassa. The largest collection of Olives known is contained in eighteen well filled drawers in the cases of the Free Public Museum of Liverpool, and I firmly believe, that if carefully examined, the two hundred and twenty species would be reduced to a dozen, or at the most, twenty. The greater part of the species named and described by myself would be reduced to the rank of varieties. An examination of the Cowries would result in a general amalgamation of whole lines of variable shells, most of which have been described as *species* for the money-value attached to a name. Let any person examine the Cypræa onyx, Linn., and compare with it such shells as C. spadicea, Swain., C. pyrum, Gmel., C. physis, Brocchi, &c. These two last-named shells are closely allied to varieties of C. carnicolor, an acknowledged variety of C. onyx. The C. eburnea, Barnes, C. miliaris, Gmel., and C. Lamarckii, Gray, are the same shell, the one an albino and the other two differently marked varieties, the C. turdus, Lam., might follow as a somewhat flattened variety. The offshoots of C. cribraria, Linn., should never have been separated

into anything more than varieties. C. Cumingii, Gray, C. Gaskoinii, Reeve, C. esontropia, Duclos, C. Peasei, MSS., and C. cribellum, Gask., are the varieties referred to. The Conus marmoreus, Bandanus, Nicabaricus, Kraussii, nocturnus, de Burghiæ, &c., are a series of varieties, and Lamarck has given in the "Encyclopædia Methodique" some very interesting unstable forms. How such a singularly marked cone as that figured in Reeve's "Conchologia Iconica," pl. 14, f. 74, should have escaped without being honoured by a specific name is a marvel. In the genus Marginella, that line of cylindrical shells commencing with the largest, M. philippinarum, Redfield, and ending with the M. minina, Guilding, are a very undistinguishable lot. The Volutes, taking the V. reticulata, Reeve, as a starting point, and finishing with V. prætexta, Reeve, including V. undata and its varieties, Ellioti and Angasi, pallida, Turneri, &c., form a series of one variable shell.

The changes taking place in the opinions, not only of conchologists, but of scientific men generally, are destined to improve the basis upon which systematic zoology rests. Many of the dogmas propounded during the early ages of scientific research have continued to the present time, the question never having been asked, how far these opinions were liable to be modified? Many, nay I may say most, of the older Naturalists who had imbibed their ideas in their youth and tenaciously held on to them as long as they lived, have passed away, and it is to be hoped the greater part of the prejudices obstructive to science have gone with them. An entirely new school has emerged into life and activity, cultivating an earnest desire to uphold only that which is true, and ready at least to give a fair hearing to the opinions of others. We are just emerging out of a false system, and find ourselves surrounded by students whose minds have been gradually preparing for the great changes taking place and that are likely to result from the combined efforts of many master minds.

The characters on which molluscous genera and species have been founded are more or less artificial, admitting the existence of true but unsuspected affinities between the Testacea of distant genera. The great work of the future in conchology will be that of

tracing the descent of recent from fossil forms; an arduous task in which an artificial system is certain to mislead its adherents. The writer's aim will be accomplished if the foregoing imperfect notes shall in anywise prove helpful to future investigators in illustrating the derivation of recent from extinct forms amongst the objects of his study.